

Xucheng Liu

# Building a Harmonized Supply Chain Management

Based on Supply Chain Modularity

---

Helsinki Metropolia University of Applied Sciences

Master's Degree

Industrial Management

Master's Thesis

06 May 2016

## **PREFACE**

It has been a wonderful journey. I have learnt a lot during the 2015 autumn and half year thesis writing. I would like to take this opportunity to thank all the people who offered help to me.

I want to thank my instructors Dr. Teerikangas and Jari Laine for giving me a lot of support. I also thank Zinaida Grabovskaia for her great help and comments on my thesis. I have learnt not only the knowledge from the classmates and teachers, but also how to continue studying by myself. I also want to thank all my wonderful classmates who have been showing me positive attitude and great Finnish culture during this past year.

I want to thank the case company for giving me the opportunity to write on this topic. I want to thank all the colleagues who contributed their time and energy in helping me with my thesis. Many thanks to Jussi Lahti, who has been giving me a lot of innovative ideas. Massive thanks to Mikko Orava, my instructor and the program manager in the case company, for not only giving me the opportunity to write thesis on this project when I didn't have a thesis topic, but also for giving me constructive and critical opinions throughout the thesis process. I have gained a lot of experience about the case company processes and also got new friends during this period.

I would like to take this opportunity to thank my wife, as she deserves special thanks for not only supporting me when I was writing the thesis day and night, but also for giving me positive energy. The journey has come to an end and it is time to start another challenge.

Xucheng Liu

Helsinki, 06 May 2016

## ABSTRACT

Author Title Number of Pages Date	Xucheng Liu Building a Harmonized Process for Project Supply Chain Management 77 pages + 5 appendices 06 May 2016
Degree	Industrial Management
Degree Programme	Master of Engineering
Instructors	Jari Laine, Doctoral researcher, Aalto University Zinaida Grabovskaia, Senior Lecturer, Metropolia Mikko Orava, Program manager, case company
<p>This thesis builds a harmonized SCM process for the case company. The case company currently has two supply chain units in Finland. The key milestones and main process flows of the two units are the same. However, two units are using different tools, process documents, and practices in managing projects.</p> <p>This study is a qualitative case study research. The study collects the data from multiple sources i.e. group discussions with core team, interviews and also the case company's internal documents. With those resources, the study created the current supply chain management processes for both supply chain units. The findings from the current state analysis revealed the issues that make the two units' process differences, which can be divided into three categories. The literature review focused on the two different types of supply chain management-make to order and engineer-to-order, two different types of organization structure-process oriented and project oriented, and the approach that harmonization through the supply chain modularity. Based on these literatures the conceptual framework for this study was created.</p> <p>The outcome of this study is a harmonized SCM process. The new process is a modular based process with three categories based on the project complexity. The final proposal is linked to the case company main project structure, which enables it to link all the process together. The outcome of this study utilizes the supply chain modularity so that enables the case company have one way of managing supply chain projects for different units.</p>	
Keywords	Supply Chain Management, harmonization, Supply Chain Modularity

## **Contents**

Preface

Abstract

Table of Contents

List of Figures

List of Tables

Acronyms

1	Introduction	1
1.1	Case Company Background	1
1.2	Business Challenge	2
1.3	Objective and Outcome of the Study	2
2	Method and Material	4
2.1	Research Approach	4
2.2	Research Design	5
2.3	Data Collection and Analysis	6
2.4	Validity and Reliability Plan	10
3	Current State Analysis	12
3.1	Overview of the CSA Procedure	12
3.2	Overview of the SCM Project Business in the Case Company	13
3.3	Current Project SCM (Comparison of Unit A and B)	16
3.3.1	Current SCM Practices in Unit A	17
3.3.2	Current SCM Practices in Unit B	19
3.3.3	Current Component Listing Process (Stage 6)	23
3.3.4	Current Component Engineering Process (Stage 7)	24
3.3.5	Current Ordering, Production and Logistics (Stages 8-10)	24
3.4	Key Findings from Analysis of the Project Process in Finnish Units A and B	25
3.4.1	Key Similarities between Units A and B	27
3.4.2	Key Differences between Unit A and B	27
4	Harmonization Process for Different Type SCM	31
4.1	SCM Overview	31
4.2	SCM in Construction Business	32
4.2.1	MTO (Make- to-Order) SCM	32
4.2.2	ETO (Engineer-to-Order) SCM	34

4.2.3	Comparison of the ETO and MTO SCM	35
4.3	Two Types of Organization Structure	38
4.3.1	Project Oriented Organization Structure	38
4.3.2	Process Oriented Organization Structure	39
4.3.3	Comparison of the Project & Process Oriented Organizations	40
4.4	Harmonization and Modularity	42
4.5	Conceptual Framework	43
5	Building a Concept for Both Supply Chain Units	46
5.1	Overview of the Proposal Building Stage	46
5.2	Findings of Data Collection 2	48
5.3	Draft Proposal for the Project Process for Units A and B	49
5.3.1	Common Module (Module 1)	51
5.3.2	Low and Medium Modules (Module 2)	52
5.3.3	Low Module SCM Process (Module 3)	52
5.3.4	Medium Module SCM Process (Module 4, 5, 8 and 9)	55
5.3.5	High Module SCM Process (Module 6 and 7)	61
5.3.6	Harmonized Documents for the New SCM Process	66
5.4	Summary of the Draft Proposal	67
6	Validation of the Proposal	68
6.1	Overview of the Validation Stage	68
6.2	Findings of Data Collection 3	68
6.3	Final proposal for Supply Chain Process for Both Units	70
7	Discussion and Conclusions	73
7.1	Summary	73
7.2	Managerial Implications	74
7.3	Evaluation of the Thesis	75
7.3.1	Outcome vs Objective	76
7.3.2	Reliability and Validity	76
7.4	Closing Words	77
	References	78
	Appendices	
	Appendix 1. Internal documents management	
	Appendix 2. Questions and Field Notes for Data 1	
	Appendix 3. Interview Memo (Data 2)	
	Appendix 4. Workshop Memo (Data 3)	
	Appendix 5. Supply Chain employees' responsibilities in managing the project	

## List of Figures

Figure 1. Research design in this study. ....	5
Figure 2. General Project process of the case company. ....	13
Figure 3. The general SCM process in the case company. ....	14
Figure 4. Project process in the case company. ....	14
Figure 5. Simplified process map of the case company project SCM. ....	16
Figure 6. Value stream map (VSM) of the current Unit A & B process. ....	26
Figure 7. A typical MTO process (Karim et al. 2008: 2391). ....	33
Figure 8. The general ETO process (based on Pandit and Zhu 2007). ....	35
Figure 9. The delivery leadtime for different product type (Handfield 1994: 386). ....	36
Figure 10. The simplified process comparison for ETO & MTO SC (based on Karim et al. 2008: 2391, and Pandit and Zhu 2007). ....	36
Figure 11. The procurement process for project-oriented organization (based on Elfving et al. 2005: 180). ....	39
Figure 12. Conceptual framework of this thesis. ....	44
Figure 13. The draft proposal of the SCM process. ....	50
Figure 14. Module 1, Common module-from Bidding to first PCCP. ....	51
Figure 15. Module 2, Low & Medium – From provide price to order to second PCCP. ....	52
Figure 16. Module 3, Low category SCM process. ....	53
Figure 17. Module 4, Medium-from PO kick-off to Basic engineering. ....	56
Figure 18. Module 5, Medium complexity - from Submit drawing to Solution approved. ....	58
Figure 19. Module 8, Medium & High-from Final order to Permission to manufacturing. ....	59
Figure 20. Module 9, Common-from Material management to All products on site. ....	60
Figure 21. Module 6, High-from SCM involve to Order to ERP. ....	62
Figure 22. Module 7, from Basic & Detailed engineering to Engineering sourcing, quality plan ready. ....	64
Figure 23. The final proposal for the harmonized SCM process. ....	71

## List of Tables

Table 1. Data collection in rounds 1-3.....	6
Table 2. Data 1 collection for two different SC units – Project keepers. ....	7
Table 3. Data 1 Collection from the Other Perspective in the SC process.....	8
Table 4. Case company internal documents in milestones review. (Appendix 1) .....	9
Table 5. Data 2 and 3 Collection from the project team and program manager.....	9
Table 6. Key types of differences to be harmonized between Unit A and B.....	28
Table 7. The differences and similarities from the literature for MTO and ETO SCM. .	37
Table 8. The process of approaching problems in the process-oriented organization (based on Hagel et al. 1993: 55).....	40
Table 9. The key themes of the Project & Process Oriented organization.....	41
Table 10. Categories suggested for the process flowchart of the draft proposal. ....	48
Table 11. Suggestions from stakeholders for the harmonized proposal. (from Data 2)	49
Table 12. Document categorize based on the customization level for both units.....	66
Table 13. Proposed SCM modularity based on the current state. ....	67
Table 14. Summary of Data 3: Feedback for the initial proposal. ....	69
Table 15. Action plan for building the harmonized process. ....	75

## Acronyms

SC	Supply Chain
SCM	Supply Chain Management
FL PM	Front Line Project Manager
SM	Supply Chain Manager
PE	Supply Chain Project Engineer
ERP	Enterprise Resource Planning
ETO	Engineer-to-Order
MTO	Make-to-Order
Unit A	Supply Chain Unit A in Finland
Unit B	Supply Chain Unit B in Finland
PCCP	Project Complexity Check Point
VSM	Value Stream Map



## 1 Introduction

This study explores the challenges of harmonising processes in supply chain management (SCM) in the construction business field. The study focuses on projects in SCM done by the case company that is one of the leading service providers in construction business. SCM is a very important factor for any company seeking to solidify activities and compete for its position in the marketplace. A supply chain (SC) is a complex process encompassing the activities of moving the goods from the raw materials stage through to the end user (Brewer and Speh 2000).

In the case company of this thesis, SC are highly complex since they serve sophisticated technology products. Moreover, there are currently two different SC units in Finland which have their own practices and perform on the same level, according to the same process flow chart. As a result, SCM in the company requires special attention and is subject to improvement. In order to make the company more competitive, this thesis studies and harmonizes the two SC units processes so that make the whole structure less complex.

### 1.1 Case Company Background

The case company of this thesis is one of the global service leaders in construction business for some special equipment. The organization model is a project based structure, and the whole project process is from pre-bid to handover to manufacturing the final solution provided to the customer. In the construction business there are many different building segments, for example, office building, retail building, hotel building, residential building, infrastructure, medical building and special buildings. The case company services all of them, which makes its SCM especially complex.

In the early 2000s, the company had only one SC unit in Finland (Unit A). Following the booming growth of the market and company's globalization, the whole SC Unit A could not meet all the customer's needs and requirements. Under these circumstances, the management decided to establish a new SC unit (Unit B) and made a clear service scope for both SC units. Unit A focuses on the volume business which does not require much special engineering and concentrates on low risk projects. Unit B concentrates

on the tailored business which requires highly special engineering, new pilot products and also manages the projects with value over a certain amount. The company has a clear road map for the project process delivery. However, after many years of development, both units have formed their own, slightly different practices under the company main structure.

## 1.2 Business Challenge

As introduced in Section 1.1, the main structure of the key milestones and process flows for the two units are the same. However, two units are using different tools, document management and practices under the main structure. This phenomenon causes the existence of two different, parallel processes under the main structure. These different processes cause extra project activities, different process development needs, additional maintaining costs and time consumption. Furthermore, the processes themselves generate too many tools which make them even more complex and inefficient. On top of that, since the company is currently mapping their strategically processes from the pre-bid to the project handover, the extra process is making the mapping a much more difficult task.

From the practical perspective, it has become evident by now that the two different processes cause Front Line Project Manager (FL PM) confusion in managing the projects with the Supply Chain Manager (SM) together. Since it often happens that one project is sometimes divided between two SC units, PM has to work in different ways between the SC units A and B. Finally, due to the different practices under the company main structure, the lead time becomes different, and the engineering cost differs too, which will go to PM and increase the whole project cost.

## 1.3 Objective and Outcome of the Study

The objective of this study is to build a common and harmonize the supply chain management (SCM) process for the two Supply chain (SC) units of the company. The approach is to examine the current process in the two SC units, exam the performance especially focusing on the key milestones from the process, and finally propose a common and better process for the two SC units of the company.

The outcome of this study is a new, harmonized process for both SC units in managing projects, which includes: (a) a process flowchart, (b) check-list for project stages, (c) roles and responsibilities.

The thesis is written in seven sections. Section 1 introduces the problem and logic of the solution. Section 2, Method and materials, explains the logic of the research approach in this study. Section 3 analyses the current state of the case company SCM practices. This analysis is made in order to understand the Unit A and B's current practices, find out the underlying differences and similarities of both units. Section 4 discusses the literature regarding the management of project-based and process-based SCM structures. Section 5 contains the first draft proposal of SCM model for two SC units and gives the detailed list of the key milestones of the process. Section 6 collects more data from the management team and builds the final, harmonized proposal of the SCM practices for the units. Section 7, the summary, discusses the results as well as the reliability and validity of the solution. In addition, it also provides the managerial implications for the next step for the company.

## 2 Method and Material

The section discusses the research approach of the study. This section also formulates the research design and presents the way data is collected and analyzed.

### 2.1 Research Approach

Yin (2003) describes the case study as “an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. Eisenhardt (1989) describes “the case study as a research strategy which focuses on understanding the dynamics present within single setting”. The strategy of a case study first focuses on the phenomenon that occurs in the organization. Then, it studies and explores the reason behind the phenomenon. Finally, it solves the problem through the qualitative data collection and the literature search. The case study emphasizes the rich, real-world context in which the phenomena occur (Eisenhardt and Graebner 2007). The case study also emphasizes the case company’s business problem. The research questions play an important role among the research strategy (Yin 2003), guiding the research process to the final outcome.

This study belongs to the qualitative research strategy. As Gillham (2010) describes, “the qualitative methods focus primarily on the kind of evidence (what people tell you, what they do) that will enable you to understand the meaning of what is going on”. This study focuses on the evidence that what is the process in the documents and what people really do in order to map the process in an objective manner.

This study chooses a case study as its research approach because the study is based on the real world business phenomenon and involves qualitative data. The study collects the data from multiple sources i.e. group discussion with core team, interviews and company internal documents. By further research step by step, the study explores the problem area and makes the research more specific and deeper. Moreover, in line with the case study approach, this study takes different perspectives from different departments in the case company to get the various answer to provide a grounded proposal to the case company.

## 2.2 Research Design

The research design of this study consists of five main parts: (1) business challenge and objective, (2) the current state analysis, (3) existing knowledge review, (4) building draft proposal and (5) final proposal of the new SC process. During this study, the implementation of the new SC process is not done. Figure 1 shows the sequence of this study.

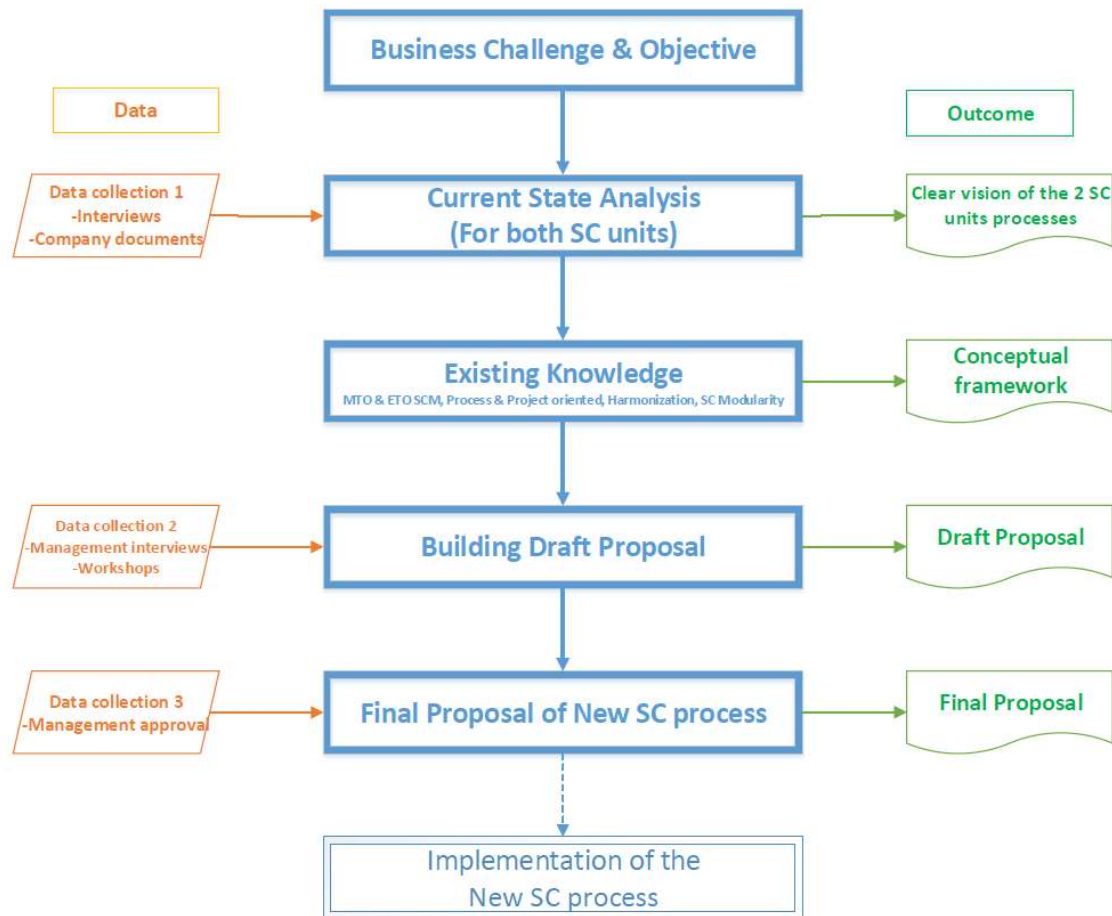


Figure 1. Research design in this study.

Figure 1 shows the research design for this study. In stage 1, the research starts with the business problem identification and sets the objective of building a harmonized process for two SC units. The outcome from the current state analysis is to get a clear vision of the similarity and differences between Unit A and B. In stage 3, the study examines the existing knowledge and the focus is on the SCM and business process harmonization. In stage 4, the focus areas are, first, on combining the current state analysis and the findings from existing knowledge to identify possible suggestion for

proposal building; then, conducting interviews and collaborating with the process users, collecting data and feedback for building the draft proposal. In stage 5, the proposal is validated with the management team for the draft proposal. The final outcome will be written based on the feedback from the stakeholders as the draft proposal.

### 2.3 Data Collection and Analysis

Data collection in this study is divided into rounds 1-3. Data 1 for CSA, Data 2 for proposal building of the new SC process, and Data 3 for validation of the proposal. Table 1 below briefly list all data included into each round.

*Table 1. Data collection in rounds 1-3.*

Data	Data sources	Purpose	Analysis in
Data 1, CSA	1. Project core team discussion	Set the target for the study purpose, discusses the current SCM process	Section 3, CSA
	2. Interviews with project handlers	Map the current process and find the similarities and differences	
	3. Interviews with engineers in engineering department	Collect the process documents for Unit A & B, find out which unit process support their daily works better.	
		Objective views of the SCM process for Unit A & B	
	4. Company internal documents	Map the current process and find the similarities and differences for process documents	
Data 2, Building the proposal	5. Group discussion with the key stakeholders	Suggestion for building the proposal related to: Modular SCM process, project complexity	Section 5, Building the proposal
Data 3, Validating the proposal	6. Discussion with key stakeholders and program manager	Identifying for the improvement area	Section 6, Validation
		Evaluation of the proposal	

In Data 1 for the current state analysis, the data collection contains three parts. First, in Data 1, the study reviews the process, and tools and documents to build the general model of the case units. In addition, interviews in the two SC units are conducted to analyze the different way of their working. Here, the information is collected in the area which the processes are overlapped of the two units by the form of interviews. This data points to the different ways of working and their effect on the process flow.

### *Interviews, discussions*

This study collects data from the key stakeholders from the SC units in order to get different perspectives of the topic. Table 2 and 3 show the details of data collection used for identifying differences and similarities in two SC units, in Data collection 1.

*Table 2. Data 1 collection for two different SC units – Project keepers.*

	Participants	Position in the process	Date and Duration	Documented as	Topic Discussed
1	PM in Unit A	SC project management	02.02.2016, 1 hour Face to face	Field notes (appendix 2)	1 Unit A process general overview
3	SM in Unit B	SC project management	10.02.2016, 1 hour Face to face	Field notes (appendix 2)	2 The different between Unit A and B
4	SM in Unit B	SC project management	11.02.2016, 1 hour Face to face	Field notes (appendix 2)	3 The Strength and Weakness of the process
5	SM in Unit B	SC project management	28.02.2016, 1 hour Face to face	Field notes (appendix 2)	4 The development needs in the Unit A process
6	Project core team	Stakeholders, Program manager	04.02.2016 Workshop, 1 hour	Field notes (appendix 2)	Harmonization project process discussion, kicking off meeting.
7	Project core team	Stakeholders, Program manager	24.02.2016 Workshop, 1 hour	Field notes (appendix 2)	Process documents gathering for Unit A & B
8	Project core team	Stakeholders	26.02.2016 Workshop, 1 hour	Field notes (appendix 2)	Process documents review

Table 2 collects the data presented from the project keepers' perspective, the project manager and the supply manager. As seen from the table above, the main method of the data collection for this study is face to face meeting. The interviews were conducted as semi-structured face-to-face interviews. The interviewees received the questions before the interview and all the interviews were recorded by tapes. After the interviews, the field notes were finalized based on the voice record to ensure the correctness of the interviews. The records of the interviews are shown in the appendix 2. In this study, the topics for interviews focused on the project SCM process and the data aimed to identify the difference between the two SC units as well as the similarities.

Table 3 below shows the data collected from the engineers who work with SM in the SC process. Because the engineers work with both units, this data is from different angles to compare the differences and similarities between the two units.

*Table 3. Data 1 Collection from the Other Perspective in the SC process.*

Participants	Position in the process	Date and Duration	Documented as	Topic Discussed
Listing engineer	Engineering listing	23.02.2016, 1 hour Face to face	Field notes (appendix 2)	1 The daily work and process. 2 What kind of elements could facilitate their work from the SC unit perspective 3 What is the different issues when work with Unit A and B
Mechanical engineer in Unit A	Detailed engineering	16.02.2016, 1 hour Face to face	Field notes (appendix 2)	

As shown in Table 3, the Interviews are done with engineers in engineering department. Table 3 data are analyzed together with the data from Table 2 in order to get a comprehensive perspective of the SC process. In this study, the method of analysis was the Thematic analysis of interview and discussion data.

#### *Internal documents*

This study also utilised the analysis of the company's internal documents in addition to the workshops and interviews. The documents are shown below in table 3 (details are given in Appendix 1). In this study, the documents are collected first in order to map the current process in Data 1. Moreover, the documents are analyzed and sorted by the case company project team during the group discussion in Data 2. The study also combines and categorizes the case company internal documents for the outcome of this.



*Table 4. Case company internal documents in milestones review. (Appendix 1)*

Stage	Description
1	SC unit receive order and related documents
2	Make submittal drawings
3	SC unit submits approval drawings to FL
4	Drawings and documents clarification
5	Check the order specification
6	SC list the order items and clarification of the order
7	Component engineering
8	All issues clarified
9	Manufacturing
10	Material transportation
11	Installation, handover to the customer
Other	Special requirements documentation

As shown in Table 4, the documents are collected from the stage SC unit gets the order until the material installation finished. The analysis of the internal documents made the important part of the data collection and was done in order to get a more comprehensive understanding of the Unit A and B' processes.

#### *Interviews, discussions*

For Data 2 and 3 this study collects data from the project team as well as the program manager. Table 5 shows the details of data collection used for co-creating the proposal draft and suggestion for the final proposal of this study, in Data collections 2 and 3.

*Table 5. Data 2 and 3 collection from the project team and program manager.*

	Participants	Position in the process	Date and Duration	Documented as	Topic Discussed
1	PM in Unit A, SM in Unit B	SC project management	24.03.2016 1.5 hours Group discussion	Field notes (appendix 3)	1. Review the Unit A process documents 2. Co-create for the draft proposal 3. Combine the process documents for Unit A & B 4. Discuss what to be harmonized for unit A and B
2	Program manager	SC project management	14.04.2016 1 hour Face to face	Field notes (appendix 4)	1. Get feedback and improvement area for the draft proposal 2. Suggestion for the final

As shown in Table 5, the data is collected from the group discussion and face-to-face interview. Data 2 is collected from the group discussion in order to co-create the draft proposal. Data 3 is collected from the interview with the program manager in order to get feedback for the proposal. The records of the group discussion and interview are shown in Appendices 3 and 4.

## 2.4 Validity and Reliability Plan

The validity and reliability have to be evaluated to prove the results of the study. The validity and reliability could not separate from each other in the research. Moreover, "the validity estimates the extent to which the test or set of data or design actually measures or reflects or produces what is supposed to measure, reflect, or product." (Jha 2008: 103). There are two types of validity which is internal and external reliability.

*The internal validity* is a particular strength of qualitative research because the data itself tell about the subject of study (Quinton & Smallbone, 2006:128). To ensure the internal validity of this study, the core team for this study will be built and the members should be from both Unit A & B in order to get a comprehensive view of the process. Additionally, many group discussions will be organized to set the scope and target of the study harmonized process project. Moreover, the interviews with the relevant company employees need to be organized in order to gain a clear and objective picture of the current Unit A & B process. In addition, the company internal documents will be reviewed and discussed during the process to map the similarities and differences for the Unit A & B.

*The external validity* is defined as an assessment of whether the results could be applied to other contexts or situations (Quinton & Smallbone, 2006:129). In this study, the external validity is planned to be ensured by building the final proposal based on the relevant findings from the literature review accommodating different perspectives and fields. This will ensure the theory in this thesis is drawn from the wide sources from across the fields as well. This study also suggests that the proposal of the thesis could be piloted in small projects.

*Reliability* of a study could be improved by the following way as Quinton & Smallbone (2006:130) suggest: (1) using differing data sources, (2) using different data collection tools, (3) Applying established theory from one area to another, (4) collecting data at different time points, and (5) using different researchers at different points of the research.

To improve reliability, this study will, first, use multiple sources such as the core team discussion, interviews with key stakeholders and project handlers to support the argument. Second, the study will collect the data by semi-structured interviews and internal documents review to ensure the process is reviewed and mapped by different approach. Thirdly, the literature will be reviewed from different aspects in Supply Chain Management to ensure the reliability of the utilized literature sources. Fourth, the data for this study will be collected from three rounds to ensure the data is collected throughout the study period. Finally, the author collected the data and information from different perspectives such as program manager, employees in Unit A & B, and engineers in other department. This is planned to ensure reliability of this study.

Validity and reliability of this study will be reviewed in Section 7. The next section discusses the current state of SCM in Unit A & B.

### 3 Current State Analysis

This section discusses the case company's overall project business structure as well as the SCM practices in two units. Furthermore, this section maps the general process of the two units and the differences need to be harmonized for this study.

#### 3.1 Overview of the CSA Procedure

The current state analysis (CSA) was conducted from January to February 2016 during the thesis period in the case company. In order to conduct the CSA, the core team including the experts from Unit A & B were involved from the case company. Furthermore, the project handlers from Unit A & B, two engineers from engineering department participated in this thesis project. In addition, the company internal documents were reviewed in the CSA in order to get the comprehensive view of the whole process map.

The first part was to introduce the current project business in the case company. This gives an overview of the current project business and in which circumstance the SCM process is under.

The second part was to analyze the current SCM practices in both units. In order to map the clear picture of the case SC units' business practices, the current state was conducted from three perspectives: (a) the Unit A SCM practices, (b) the Unit B SCM practices, and (c) the conclusion of the similarities and differences between Unit A and B.

First, from the Unit A SCM perspective, this study created the process map and investigated project handler practices. The data was conducted through the interviews, core team discussion and documents review. Second, from the Unit B SCM perspective, this section focuses on the process map and project handler practices. Finally, the value stream map (VSM) is used as a tool to show the process maps for both Units in this section. The VSM visually shows the similarities for the two SCM process as well as the differences. In addition, other than the visual similarities and differences from the VSM between Unit A and B, this section analyzes the deeper reasons which make the

two SCM process different-the organization structure, the SCM process and the SCM project resource.

### 3.2 Overview of the SCM Project Business in the Case Company

SCM Project process in the case company makes part of the whole Project management in the case company. The project process starts from the Leads and ends with Maintenance. Figure 2 below shows the whole process of the case company, it also highlights the scope of this study, the supply chain management (SCM) area.

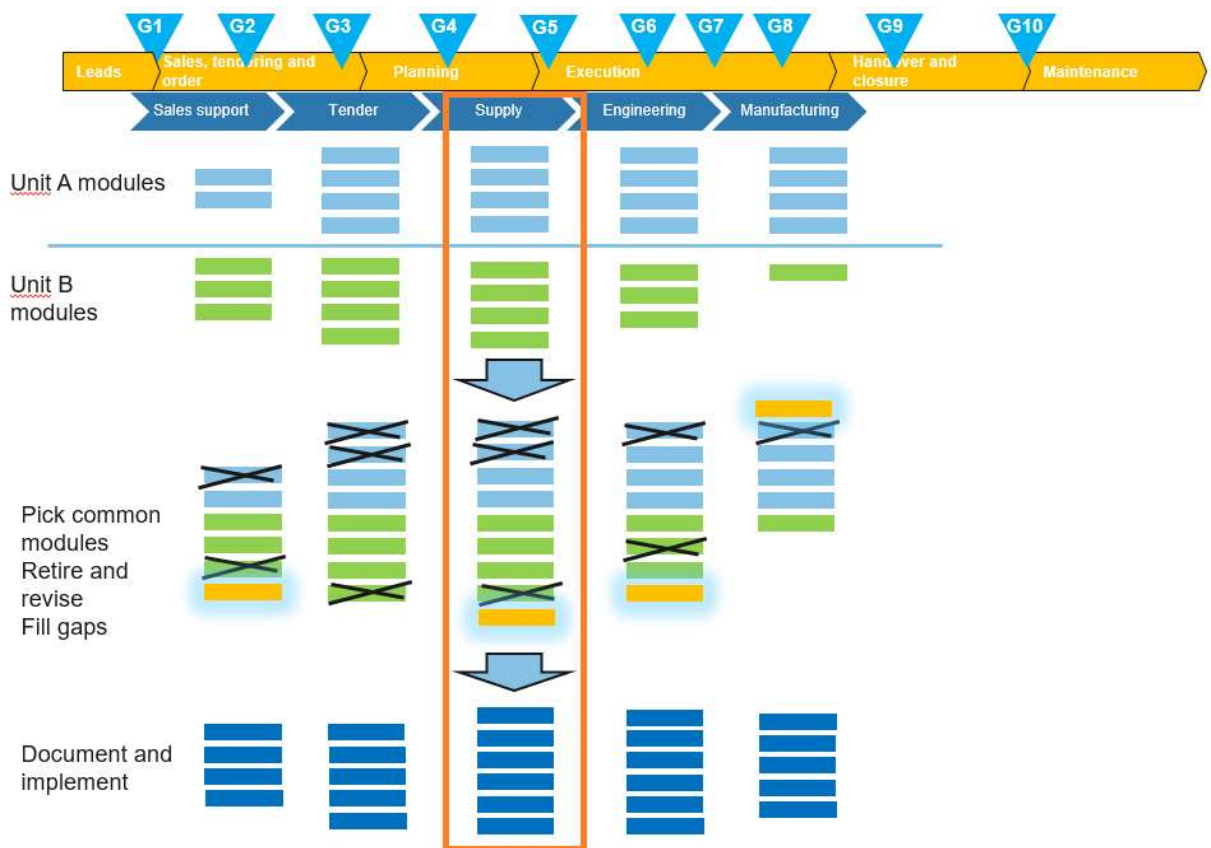


Figure 2. General Project process of the case company.

Figure 2 illustrates the general project process of the case company, which includes five main stages: Leads; Sales, tendering and order; Planning; Execution; Handover and closure, and Maintenance. The figure also shows the focus of this study, the Supply chain phase in the entire process chain. The figure also shows the existence of two SC units in the case company structure. Figure 3 below shows the SCM process in the case company and it is under the company main project (Figure 2).

Figure 3 shows the SCM process under the company's main project process (Figure 2).

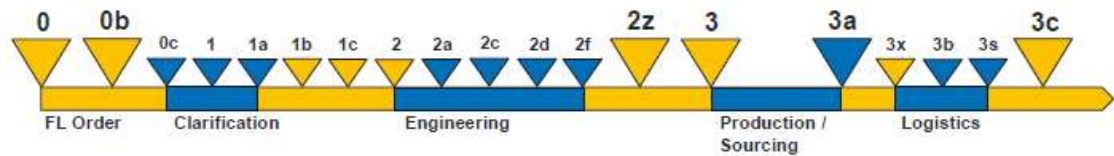


Figure 3. The general SCM process in the case company.

As shown in Figure 3, the key milestones in the SCM process are 0c, 1a, 2, 2f, 3, 3a and 3s. However, two facts complicate this picture from the SCM perspectives. First, the Project process is quite complex, and second, it differs in two SC units. In order to better describe the difference between the units, the project process will be discussed stage by stage below as currently implemented in both units. This will create the basis for harmonization of the two processes later.

The general Project process also flows from the leads (bidding) to maintenance. The Project process includes the following project stakeholders and major process (a) the customer, (b) PM, (c) SM, (d) engineering department, (e) material management team, (f) the suppliers, (e) the logistics, (f) the installation team, and (g) sometimes the R&D department when the project is very complex. Figure 4 below shows the core steps in the general Project process has.

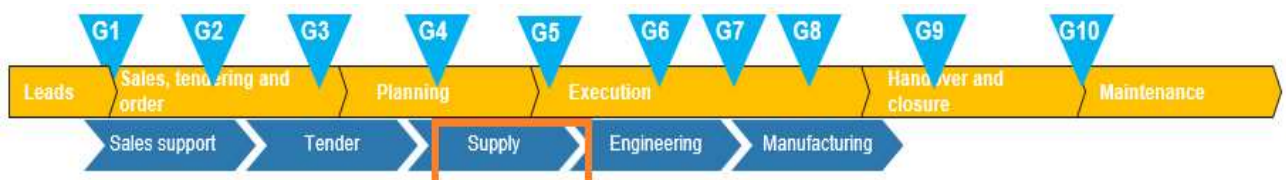


Figure 4. Project process in the case company.

As seen from Figure 4, the project flow in the case company includes six parts. Leads, Sales, tendering and ordering, planning, execution, handover and closure, maintenance.

*In the Leads period*, the salespeople notice that somewhere there is a project and also get the specification provided by the customers. First of all, the owner publishes the tender notice through a bidding company. Secondly, the supplier registers themselves

according to the tender notice. Besides, in addition, the supplier also gets or purchases the prequalification documents from the bidding company

*In the Tendering and ordering stage*, the case company will decide if the bid will be continued after evaluating the attractiveness and ability. If the management team has decided the company will continue bidding the project, the sales team and the tendering team will work together to fulfill the bidding documents. After finalizing all the customer requirement, the sales will negotiate and discuss the contract details with the customer. Once everything is settled down, the customer signs the contract with the case company.

*In the Planning stage*, once the sales team signs the project contract with the customer, the sales needs to inform the Front Line and SC steering group about the contract. The steering group will assign the project manager who is in charge of the whole project, meanwhile the supply manager is also assigned for the project material and engineering supply. From the project perspective, the project is officially moved from the customer to the Front Line sales team. The next flow is project from the FL sales to the FL PM. Once PM is officially taking over the project, he needs to build the project team and link all the stakeholders. The most important in the planning stage is the stakeholders' kick-off meeting. In the kick-off meeting, the PM discusses the project general plan which includes the project schedule, customer involved, target material delivery schedule, risk management and all the project related information. The format of the meeting is always face to face. The SM discusses the project technical scope, supply line project structure, the confirmed price and all the supply project issues. This is the place when SC units take over the project from the FL, and the detailed process in this stage is introduces further in the next sub-section.

*In the Execution stage*, the SC PE plays the key role in this stage, because the PE keeps the project integration flow smoothly among the stakeholders. This stage is the main part of the SCM in the case company, and it includes Acknowledge, clarification, component listing, engineering, production and logistics.

*In the Handover and closed stage*, after the installation finished, the project is officially handover to the customer. In the same time the PM needs to handover the projects to the maintenance department. After the handover, there is a closing meeting

for the company internal stakeholders to study the project-the successful place, the improvement area, the lessoned learned for the other projects.

Finally, *in the Maintenance stage*, when there is any problem with the product the maintenance team from the case company will solve the problem for the customer.

As seen from this description, the Project process is unified for the whole company. The SC units are somehow working through the whole process, for example, in the bidding phase, the FL sales asks the technical support from the SC; in the planning and execution phase, the SC making the plans to deliver the project related components or technical support; after delivering the components, the SC will deal with the feedbacks related to the things it delivered. Thus, the SCM is through the whole process and it is important to know the whole process since the SC practices are under the main business process.

### 3.3 Current Project SCM (Comparison of Unit A and B)

The current project SCM exists under the main project structure from ordering to execution. This main Project process, however, is implemented differently in two SC units. The description of the current process below includes three perspectives for each stage: (a) the Process itself (as documented), (b) ERP activities and (c) collaboration.

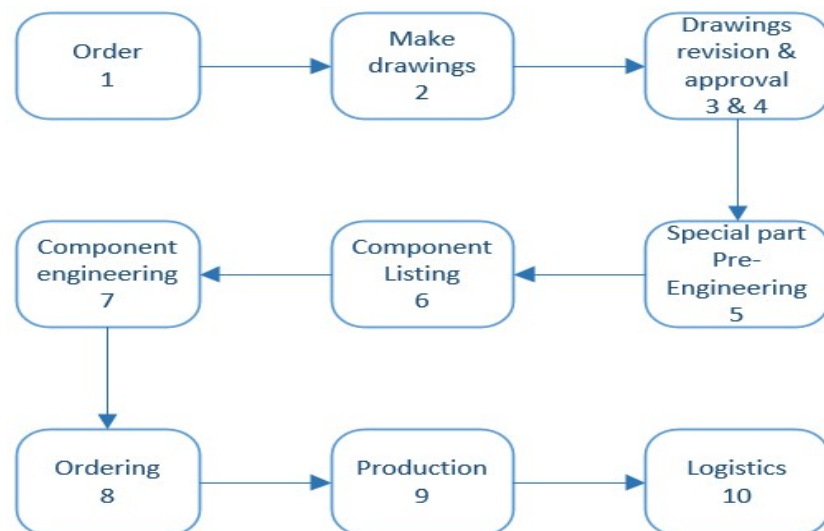


Figure 5. Simplified process map of the case company project SCM.



According to the current case company's SCM practices, there are nine steps that can be identified in the Project process as implemented by two SC units. These differences are discussed in more detail below, and the detailed practices are also slightly different with the company's main SCM practices.

### 3.3.1 Current SCM Practices in Unit A

One way of dealing with SCM projects is practiced by Unit A. There are five main steps in this process (according to the stages in Figure 5 above):

*Stage 1 is the "Order" stage.* In Unit A, there are two main parts in this stage; the front-line project manager (FL PM) gives the order documents to supply chain project engineer (PE), and PE checks the order. After the FL sales representative signs the contract with the customer, they will transfer the customer requirements to the case company's language in the format of order documents. Next step the FL PM sends the order documents (CST, CSP, KTOC) to the SL. SC PE collects and checks the order documents content. The order documents include the technical specification, the customer drawings and all the related documents & drawings. After collecting all the project related documents, the PE needs to check the document content and fill in the checking results to the SL document. If the result is "not pass", PE will ask FL clarify the unclear parts in the order documents. When everything is clear and clarified from the check list, the PE can continue the next stage in the process. Thus, this stage makes the preparing stage for make drawings.

*Stage 2 is the "Make drawings" stage.* In this stage, the PE handles the order in a very simple manner. Firstly, PE creates the order for the project in the ERP system. Because the checking part has been done in the previous stage, PE confirms the "Acknowledge" in ERP system and release the "layout" activity which lead time is based on the company's document. In the same time, PE creates the electronic folder in the company's public hard disc and save all the project related email in it. The PE sends email to FL to clarify the question from layout engineer if there is anything unclear. After the layout drawing being finished, PE will send the drawing to the FL and the SAP activity will be confirmed by the engineer. If the engineer identifies some special components need to be designed, the PE will open the activity in SAP for allocating the design work to the engineering department. In this stage, the start-up meeting is

held usually by teleconference and it last about an hour. Moreover, PE will fulfil some check lists after the meeting.

*Stage 3 and 4 is "Drawing revision & Approval" stage.* This stage is the order clarification before the engineering stage (stage 7). FL submits the layout drawings to the customer and discusses the details with the customer. If customer confirms the drawings are ok and give the approval, FL will inform the PE about the approval of the drawings. Because the construction business is dynamics when the building is going upward all the time, there will be some something customer wants to change. In this circumstance FL will send a drawing change request to PE, PE will open the ERP activity which allocates work to the engineering department. The clarification of the drawings can be several rounds. Same as in the previous stage, the ERP engineering activity is open when the special components are identified. The risk assessment is done here for the project if the risk is identified.

*Stage 5 to stage 8 is from "Special part pre-engineering" to "Orders to suppliers" stages.* The final order is sent to the PE from FL in this stage. The final order means that the all the documents and drawings have been approved by the customer. The first task PE does is to check the coherence of the documents and drawings when FL sends the final order. After the final order check, PE clarify with FL if there is unclear issue appear from the order. When the final order is clear and clarified, PE start preparing the engineering input text to continue the component listing and engineering. The lead time for the engineering and the process are based on the SAP and company's document.

*Stage 9.* This stage is the Manufacturing stage; the promise is that FL gives the permission in ERP system that SL could start the manufacturing. The permission is called "NRP" in the ERP system. After the engineering is done from the previous stage, PE informs FL that the manufacturing could be started and the earliest lead time for the material. FL inserts the materials on site date and gives the permission in ERP system.

As shown above, the SCM process performed by Unit A, is very clear in every step includes the responsibilities, the check lists, the documents and process map. However, the interviewees point out the drawbacks of the current process.

*“We are using a lot of excel forms, even let’s say checking all the orders there is excel, we are using that for every single elevator per DG. Well it’s not so good, if you find an error, it is in excel file. Xxxx (Case company) in all xxx (Unit B) and xxx (Unit A) we are really bad in and we should improve. We have 10 different order forms and FLs doesn’t know what they need.*

*-Interview 1”*

As mentioned above, there are too many checklists and order forms both PE and FL need to fill in. These documents create a lot of time and work. Moreover, the different order forms make the process more complicate in different steps.

*“The biggest difference is the way we handle the project finance that is one of the biggest. The other one is how we team up as a project (Project structure). I know in xxx (Unit B) it’s quite common that you have a chief designer for layouts always. Then you may have car engineer. That is one of the really weak point in SOF, I would say basically at the moment I am the only one who has chief engineer. Only our biggest or big projects, for those xxx (Unit A) layouts are nominated to the project otherwise there is no common understanding how important that is to get someone who understand your project what’s happening.*

*-Interview 1”*

Summing up, as mentioned by the interviewees, the Unit A is doing the project in a process *strict* manner, in the other word A is a process focus organization. Moreover, there is no normal SCM project structure; the whole process is more like the material ordering process. This causes the problems that there is no integration among the stakeholders and lack of common understanding for the project.

### 3.3.2 Current SCM Practices in Unit B

In the Unit B, there are nine milestones in the detailed process map, as described and analyzed below (differentiated from the stages in Figure 5 above):

*Stage 1.* Milestone 0 means the case company gets the contract with the customer. So in this stage, the SL’s responsibility is to get the project order and specification from the FL representatives. The project order is in A4 format and the specification covers the technical scope of the customer requirements.

*Stage 2.* There are two main parts for SM in this stage-the internal SCM and external SCM. The internal SCM means coordinate the drawings, engineering and schedule inside the company. The external SCM means communicate with the FL and customer, provide solution and clarify the order specification. There are three tools SM uses in this stage: the company documents, the ERP system and the PDM. After SL gets the official order and order specification from the FL, SC needs to make the drawings which include the layout and the visual drawings.

There are seven main tasks in this stage. First, the SM needs to open the project order in the ERP system and release the "Acknowledge" in the system. After the "Acknowledge" is released, SM will release the "layout activity" in the ERP system and input the LFD which engineering manager provides. In the activity long text, SM inputs the project information includes the core specification, SC and FL contacts, PDM link and other related information. Meanwhile, tender engineer organizes the internal start up meeting with the SM to discuss the (1) tender related issues (2) the latest core specification agreed with the FL (3) special requirements. After the layout drawing has been made, the SM needs to organize the Sourcing and Logistics Plan meeting with the sourcing manager and the quality manager to identify the (1) Project risks (2) Project special components (3) Special materials sourcing plan. When the special components are identified by the layout engineer and quality manager, SM needs to open "Clarific" activity in ERP system to the engineering department to design the special component. When all the project related drawings are made, the SM needs to check the consistency of all the documents, drawings.

In this stage, the FL's responsibility is to organize the start-up meeting with all the stakeholders in the project. The purpose of the start-up meeting is to enhance the collaboration among the stakeholders, monitor the risks in the early stage, translate the customer requirements into case company language to be sure the SL and FL have the same understanding of the project.

*Stage 5.* Start from here, the process of SC Unit A and B's are overlapped. In this stage, all the project specification and drawings should have been clarified. Firstly, SM communicates with the FL and confirms the final revision of all the purchase order related documents. After the confirmation from FL, the SM does the order check and release the "order check" activity in SAP. The order check includes the consistency

among the core specification, layout drawings and visual drawings. If the information among those documents is not the same, the SM needs to clarify the reason and ask related parties to correct the mistakes. For example, if the drawing dimensions are not drawn according to the FL order, the layout engineer needs to correct the drawing. When the order check is done, at the same time SM confirms the "order check" activity in SAP. SM releases the "Listing" activity in SAP and fill in the long text which includes all the project related information, and the special engineering which has been done.

*Stage 6.* The listing engineers proceeds the project in this stage. Listing means to input the project components into the ERP system for two purposes. First is too give the input to continue the engineering, second is that material management (MM) team could make the supplier purchase order from the ERP. After the component listing activity is done, the engineer confirms the "Listing" activity in ERP system and opens the engineering activities for engineers to fill in the mechanical, electrical parts in ERP system.

*Stage 7.* After the listing activity, the engineering activity takes place in the process. After the engineering is done, SM organizes the meeting to review the project engineering process and check the interfaces among the special designs.

*Stage 8.* After the engineering stage, all the project related information are clarified and input in ERP system. SM inputs the final price agreed with the FL into the ERP system. SM informs FL all the activities are ready and the project components are waiting to be purchased. After the information from SM, FL will check the schedule and give the permission to SM continue with the manufacturing. SM will release the permission in ERP system. Material management team creates the purchase order to the suppliers after they see the permission has been given in the ERP system.

Summing up, the current SCM process in Unit B is working in all stages and can be describes from three main perspectives. Firstly, the Documents-required and working instruction are shown inside the different stages. Secondly, the ERP perspective is taken into account, since all the work allocation is done in the ERP system. Third is the bridge among the project stakeholders, this basically means the SM links all the stakeholders and share the project information throughout the SC project. All these per-

spectives are visible in the current process; however, the documentation is often perceived as too heavy in this process, as one of the interviewees mentioned:

*“There is too many documentation, and mainly that the variation for each project they generate, it implement to all the projects.”*

*-Interviewee 5*

During the SCM process, the Unit B starts from building a very clear project structure in the beginning. This creates the common understanding for the project and also sets the sole target for the whole group. Moreover, there are also customer solution managers who provide solution and assist the project in Unit B organization perspective. The benefit of it is pointed out by one interviewee:

*“Because there is no, for example, there is no role called customer solution manager there. Here we do have, so that’s even the starting point is different.”*

*-Interviewee 2*

As mentioned above, it is different from the organization structure that Unit B has the customer solution manager department. This service could build the integration between the customer and the company. Furthermore, the company is able to provide better service because of the solution experts with their knowledge.

Summing up, some conclusions can be done from this comparison of Unit A and B. First, from the order to special part pre-engineering (Stages 1-5), currently Unit A and B are handling the project by themselves, in other words, differently over these stages. The major differences between the two SC units A and B concern the Order to Component listing (Stages 1-5). Starting from the Component listing (Stage 6) to the Logistics (Stage 10), both units handle projects in the same way and their orders go to the same departments. In the other words, So the real sequence of the current SCM process can be described in a shorter line as: (Step 1) Order handling, (Step 2) Make drawings, (Step 3 & 4) Drawing revision & Approval, (Step 5) Special Engineering, (After Step 6) Component listing (means the product ERP configurator), ordering, production and logistics which come together since similar to both units. Further on, the current SCM process may go in slightly different ways when dealing with two types of orders, Unit A and Unit B. For the SCM, the project handlers are managing the project from Stage 1

to 5. Starting from Stage 6, the project is mainly handled by the engineering department, material management department and logistics.

The following section presents the current component listing process of these departments and focuses on the collaboration with the project handlers from Unit A & B, and reveals the similarities and differences from the different perspectives.

### 3.3.3 Current Component Listing Process (Stage 6)

*The listing engineer* is the main stakeholder in this period (see Stage 6 in Figure 5). It starts with the listing team leader running the work list from the ERP system and allocating the jobs to the certain engineer. The meaning of the listing is to input the correct project components and materials into the ERP system. The normal work process is mentioned in one of the interviews:

*“Normal process consists of selecting jobs from work list, selecting the correct SAP materials, configuration of SAP materials (based on information given in listing long text, CST/CSP, layouts, M-drawings, SO’s, C-SO’s, QD’s etc.) opening engineering activities, writing information to long text of engineering activities, confirming listing activity. Besides these, there is daily collaboration with project management, layout engineers, component engineers, electrical engineers, listing engineers and material management.”*

*-Interviewee 4*

As mentioned above, the listing engineers have multiple tasks which include inputting correct materials in ERP system and collaboration with different departments. Because they check many documents and texts which are written by Unit A PE and Unit B SM, they can see the whole picture and notice which unit’s input supports them better. This is mentioned by the interviewee:

*Regarding differences of xxx (Unit A) & xxx (Unit B) projects; in my personal opinion, unclear specification occurs more often in xxx (Unit A) projects than in xxx (Unit B) projects. This leads to greater number of clarifications.*

*-Interviewee 4*

The documents are usually main communication tools for the ordering process. as indicate by the informant that unclear specification in the Unit B documents can lead great

number of clarifications. In the other word is that Unit B document for the communication with the other department is not sufficient which needs to be fixed. Whilst Unit A documents are written better and more clear. The document tool support for communication will be discussed further in the section 5.

#### 3.3.4 Current Component Engineering Process (Stage 7)

After the listing engineers finish the component input into the ERP system, they will open the engineering activities includes the mechanical, electrical hardware, electrical software, car and door. When these engineers get the ERP activities, first they check the ERP long text input from the listing engineer. After the initial checking, the engineers get the idea of the project general information, Core specification, layout drawings and visual drawings. The engineers will design the components based on the project information. There are two different kind of engineering in this stage, the standard-process and special-process. The standard-process means there is existing product which can fulfill the project technical requirement. The special-process means the current existing component couldn't fulfill the requirement and needs modification based on the existing drawings or even design a totally new parts. The engineers communicate with the SM to clarify the customer requirements. The SM's responsibility in this stage is to build a link between the engineers and the FL to insure that the FL understands the solution the case company provides to the customer. Moreover, with the smooth information flow, the FL could also tell the detailed requirements customer wants. The engineers confirm the activities in ERP system when they finalize the engineering drawings and fill in the project components information in ERP system.

#### 3.3.5 Current Ordering, Production and Logistics (Stages 8-10)

During the ordering phase, there is a certain department called material management (MM) in the case company that is dealing with the purchase orders. The MM coordinate's responsibilities are communication with the suppliers, dealing the purchase order (PO) and ERP work. The current order process is described below:

MM coordinate makes the PO, sends PO to the own factories or suppliers, requests the material delivery date from the suppliers, confirms the delivery date, coordinate the



materials delivery schedule with SM or PE if anything delay, and problems clarification during the production.

For the case company, there are two parties who support the materials – the own factory and the external suppliers. The suppliers start the production after getting the purchase order from the MM coordinate. After the materials ready the suppliers will deliver them to the case company's distribution center (DC).

After the materials are in the DC, the logistics specialists will send the materials according to the ERP system input by the SM or PE. If there is any challenge regarding the materials delivery, logistics specialist will contact PE and communicate the challenges. In these two stages, there is no document required, and the collaboration is normally fully by email. When the materials arrived on the project site, the SCM officially ends.

### 3.4 Key Findings from Analysis of the Project Process in Finnish Units A and B

As described above, two SC units have different practices, with similarities and differences between them. Since the objective of this study is to build a harmonized process for the SC units, the main attention in this part of the analysis is paid to the differences between them. The two SCM process are compared in Figure 6.

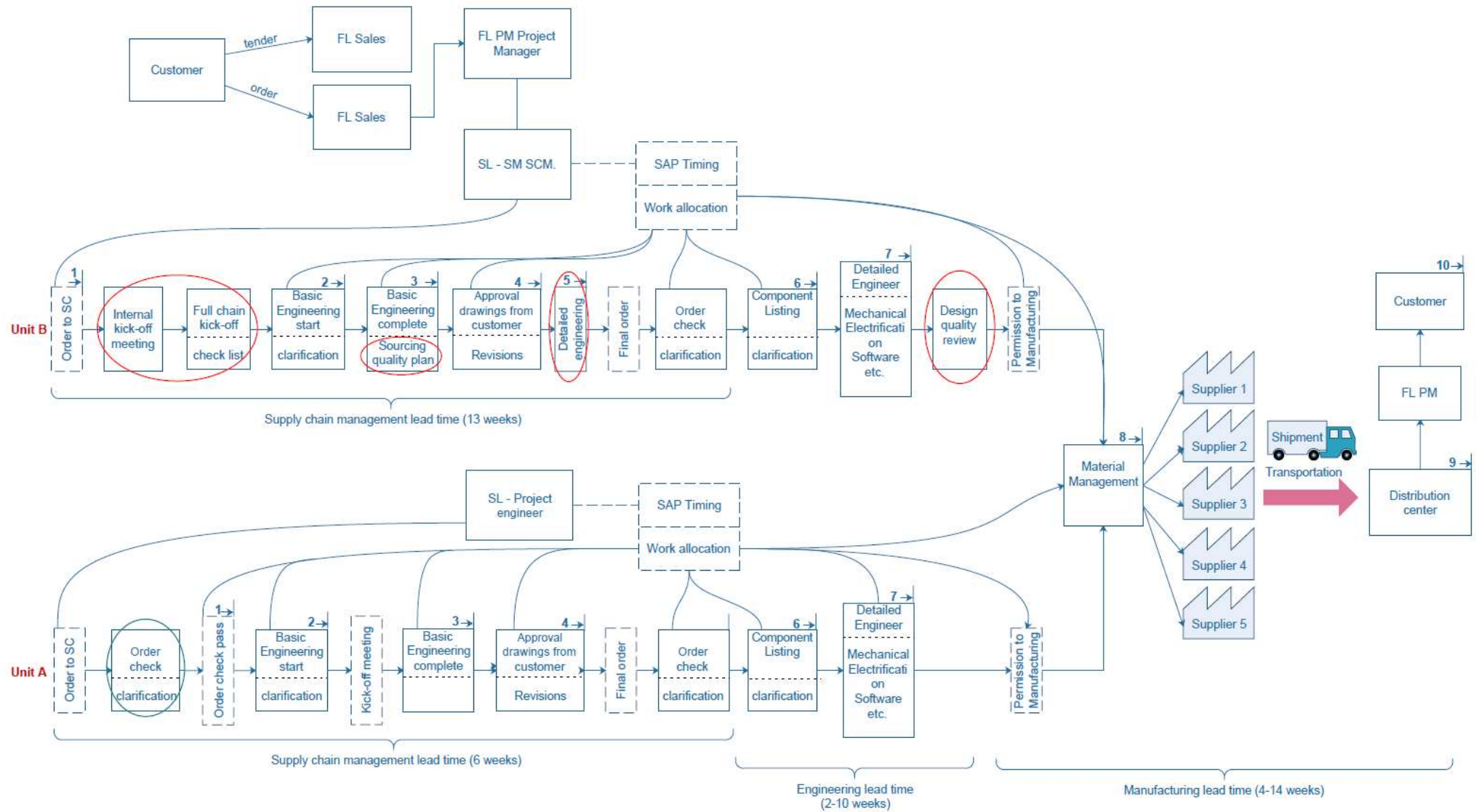


Figure 6. Value stream map (VSM) of the current Unit A & B process.

### 3.4.1 Key Similarities between Units A and B

As shown in Figure 6 above, the similarities between Unit A and B, on the global level, relate to the following features.

First, both SC units share the same main structure of the Project business flow, which lasts from the bid to the maintenance (Section 3.2). This similarity is shown in Figure 8 above that demonstrates the value stream map for both, A & B.

Secondly, both SC units are using the same main SCM practices, which also last from the order engineering to delivery (Section 3.3). However, along this process, the documentation differs much from each other.

The third similarity relates to Stages 6-10. As can be seen from the value stream maps in Figure 8 above, after the final order check by the SC units, the order processes are handled by the same department. This gives the picture that major differences in the SCM are happened before the Component listing (Stage 6). As seen from the VSM above, after the stage "Order check", both of the SC units are using the same resource.

The next section explores the differences and their impact on each process.

### 3.4.2 Key Differences between Unit A and B

The differences between Unit A and B are from two perspectives, the visual items which is shown on the VSM, and the deeper reason which is shown in Table 6 from the current state analysis.

The visual items as shown in the Figure 6, the green marks the practices which Unit A does and Unit B does not. The red marks the practice which Unit A does and Unit A does not.

For Unit A perspective. In stage 1, project engineer checks the order details when Unit A gets the order from the FL. For Unit B perspective, there are internal and full chain kick-off meetings done before stage 2. Moreover, there is sourcing and quality meeting

in stage 3. Moreover, the unit B does detailed engineering in stage 5 while Unit A does not. Finally, there is a design quality meeting between stage 7 and 8 in unit B.

The deeper differences between the two SC units which is conducted from the current state analysis as summarized in Table 6.

*Table 6. Key types of differences to be harmonized between Unit A and B.*

1. Organization structure		2. SCM process		3. SCM project resources	
Unit A	Unit B	Unit A	Unit B	Unit A	Unit B
Does not have customer solution / service department	Has customer solution / service department	Many checklists which do not support very complicated project	Many process documents	Lack of project handler	Many project handlers
Does not have process development department	Has process development department	Very strict, standardized process	Very flexible process	Not project oriented, e.g. normally no project chief designer	Clear project structure picture and support
		Not enough collaboration towards the different stakeholders	Strong collaboration towards the different stakeholders		

As shown in Table 6, the deeper differences between Units A and B can be summarized from three perspectives: (a) Organization structure, (b) SCM process, and (c) SCM project resource. In order to harmonize the two current, parallel processes, the following differences need to be reviewed and discussed internally, including their impacts, as possible targets for change:

#### I. Differences related to Organization structure

There are two major differences between A and B from the organization structure perspective. (1) The customer solution/service department which provide the supports function, (2) the process development. Point (1) is the focus area related to organization structure.

Unit B has a full set of customer support function which provides customer service in case customers are lacking the knowledge of the project related issue. Meanwhile in

Unit A because there is no customer support expert, PE or PM has to ask supports from other departments inside the company. In some cases, PE might get answer very late or even no answer, this causes the slow support to the customer. In the service business, the customer technical support is also one part in the process that could be harmonized for A and B.

## II. Differences Related to SCM Process Issues

As seen from the stage-by-stage analysis above, the documents in the process between two SC units are not the same. Furthermore, the current state that B has too many documents and A has too many checklists gives the space for harmonization.

During the process execution phase, B is sometimes too flexible this causes the problem that stakeholders lose the control of it. Whilst in Unit A the process is very strict towards the FL and engineers. The balance between the strict and flexible in the process execution needs to be solved.

When the problems or clarification are occurred, the way in B is SM organizes a meeting with the stakeholders or just gives a call. Under the same situation the way A normally does is forward the questions or clarification to the stakeholders. These two types of integration make the project collaboration very different.

The above three points are the focus area related to SCM process.

## III. Differences Related to SCM Project Resource Issues

Unit A is normally doing the project without any project structure, whilst in unit B the project structure is very clear. When the SC units get the project order from the FL, Unit B normally establishes the project team and builds up the project atmosphere. Whilst in A, there is normally no team built for the project, and the focus is majorly on the process instead of project. The project team building creates the common goal and target for the group. This is the focus area related to SCM project resource.

Summing up, the current state analyses of the two units' processes was done by interviewing key stakeholders regarding the processes in different stages, the workshops

for analyzing a possible harmonized process, two case units' internal documents, and ERP system.

The findings reveal the similarities and differences between the two SC units. The CSA focused on the differences and came to the conclusion that they can be categorized in three categories: (1) related to Organization structure, (2) related to as SCM Process, and (3) related to SCM Project resource. In order to harmonize the process for A and B, all these issues should be taken into consideration. Next section discusses the existing knowledge related to the challenges of the SCM process harmonization which should help to tackle the challenges identified in the daily practices of the case company.

## 4 Harmonization Process for Different Type SCM

This section discusses the findings from literature and existing knowledge related to different types of SCM, organizational focus and process harmonization. This section proposes a harmonization framework based on the comparison in three different domains – SCM, project & process oriented processes, and the level of harmonization.

### 4.1 SCM Overview

A supply chain is defined as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and information from a resource to a customer (Mentzer et al. 2001). Similarly, Chopra and Meindl (2016) define that a supply chain consists of all parties involved in fulfilling a customer request, and the supply chain includes the internal and external organization.

Cooper et al. (1997) argue that the Supply Chain Management is the coordination of activities and processes within the organizations in supply chain. Moreover, it is important to know the scope of SCM. As Mentzer et al. (2001) argue that the scope of SCM can be functional and organizational, where the functional scope refers to the process, and the organizational scope concerns the inter-firm relationships. Other than the scope, the framework is also important to be mentioned. The SCM framework is made of three parts-business process, management components and the structure of the supply chain (Cooper et al. 1997). In other words, the process, management components and the SC organization structure are the basic elements of the SCM. Therefore, the scope of the SCM literature review is built upon these three perspectives.

A literature review by Gosling and Naim (2013) shows, the supply chain structures can be categorized in six different types: assemble-to-order (ATO), buy-to-order (BTO), engineer-to-order (ETO), make-to-order (MTO), make-to-stock (MTS), ship-to-stock (STS) (put the literature here based on the engineer-to-order supply chain management). The focus of the study is on ETO and MTO type of SCM in construction business. Hence, the following sub-sections literature reviews literature of the SCM in construction business, the MTO, and ETO type of SCM.

## 4.2 SCM in Construction Business

The SCM in construction is defined as the “network of facilities and activities that provide customer and economic value to the functions of design development, contract management, service and the material procurement, materials manufacture and delivery, and facilities management” (Love et al. 2004).

It is argued that the traditional SCM models have been developed for a process-centric context and it is in the transposition to project-oriented contexts (Aloini et al. 2015). Moreover, according to the complexity and diversity of the construction supply chain, it is problematic to achieve the integrated delivery of the industry's projects and processes, for example, in Construction SCM (Briscoe and Dainty 2005). This indicates that the construction SCM is either project oriented or process oriented.

The different types of SCM in construction business are emphasized in many articles. One argues that the SCM in construction is a typical MTO SCM with every project creating a new product or prototype (Vrijhoef and Koskela 2000). However, another (Segerstedt and Olofsson 2010) argues there are different types of the construction SCM can be: (a) make-to-stock (MTS), (b) assemble-to-order (ATO), (c) MTO, and (d) ETO. This study further discusses the MTO and ETO, thus the following subsection focuses on these two types of SCM.

### 4.2.1 MTO (Make- to-Order) SCM

The MTO SC is managing the products with low level customized products. As Handfield (1994) argues that the Make-to-order (MTO) product is manufactured in order to meet a customers' requirement, and it is a type of process which there is little product variation.

The MTO SC order is starting to the manufacturing only after the company demand has been received in MTO SC (Youssef et al. 2004). For example, The typical MTO process is follow as below (Figure 7), (1) Standard order processing, (2) Order confirmation, (3) Customer agreement, (4) Enter order details to database & Place order to suppliers, (5) Receipt and inspection incoming parts, (6) Process set up and start manufacturing, (7) Final assembly, and (8) Shipping.



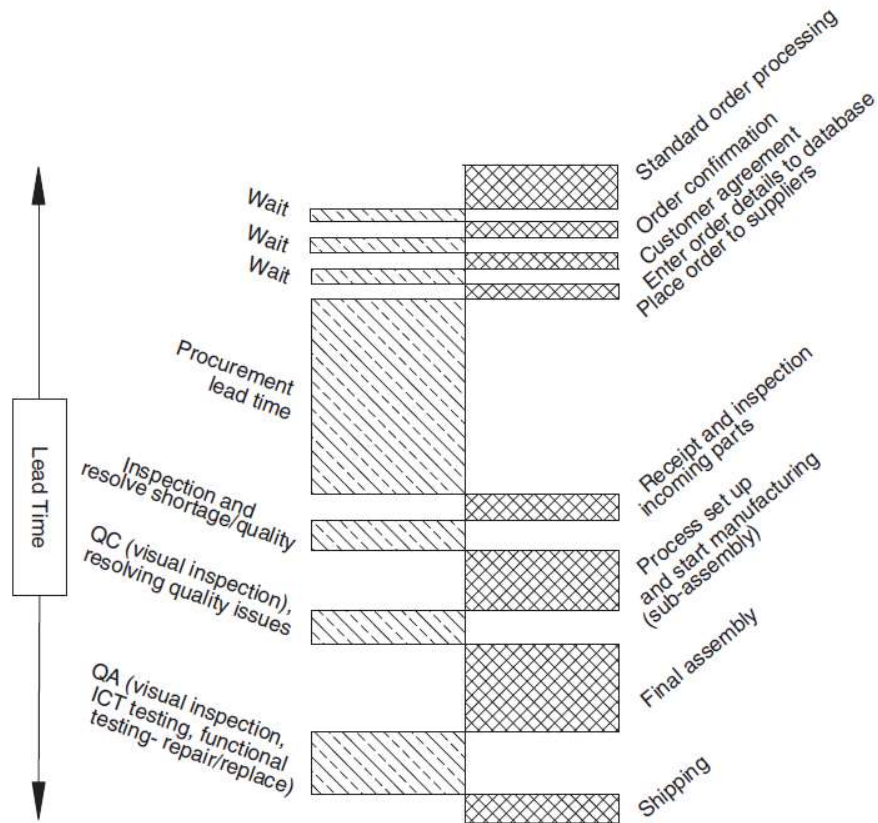


Figure 7. A typical MTO process (Karim et al. 2008: 2391).

As seen from Figure 7 above, the total lead time of the product delivery concludes two parts-the non-value added in the left, and value added activities in the right. Clearly, to eliminate the non-value added activities as a key theme in the MTO SCM (Karim et al. 2005). This MTO model will be as a reference SCM model in the section 5.

In MTO SC, normally the problem can occur not because of the product but due to the company operation mode (Jahnukainen and Lahti 1999). In the other word, the process management and insuring everything correct at the first place are important in the MTO SCM. Comparison of the ETO and MTO SCM. Moreover, MTO companies are rarely accurately forecast demand, order materials and produce in advance or effectively because of the customized products (Stevenson et al 2004). Thus, proper forecast for the customized products is important for the MTO SCM.

There are two types of supply chain, the traditional and the customized SC (Childerhouse et al 2003). Traditional SC models have been developed for a process-centric context (Aloini et al 2015). Furthermore, the studies of the MTO SCM have been fo-

cused on the process performance rather than the project work. Thus, it can be argued that the MTO SCM is majorly process-oriented practices.

#### 4.2.2 ETO (Engineer-to-Order) SCM

The ETO SC is managing the products with high level customized products. Based on the views of Gosling and Naim (2013), the engineer-to-order (ETO) supply chains has the products which requires modification or develop completely new designs.

Clearly, there is a link between the customization and the ETO supply chain. Based on Pandit and Zhu (2007), ETO is a kind of manufacturing process for mass (highly) customized products. In their paper, it is also argued that the ETO requires the design and engineering in details in order to achieve the specifications from customers. Furthermore, Haug et. 2009 argues that the ETO type of organization is the mass customizer. Thus, the mass customization is one of the features of ETO SCM.

In general, the ETO type of supply chain includes two types of products, the standard components and the customized products. The customized products normally require modification or even totally new designs. Therefore, managing the customized and standard products with different method will increase the efficiency because. For example, supply the customized products with one practice, and supply the standard products with one practice.

It is argued in business literature that ETO SCM is traditionally project oriented and good at leading designing, product development and customization performance (Camero and Braiden 2002). The typical ETO process could be found from the literature, for example, a typical ETO process is composed of six phases (Pandit and Zhu 2007), and the detailed with inputs and outputs as shown in Figure 8 below.

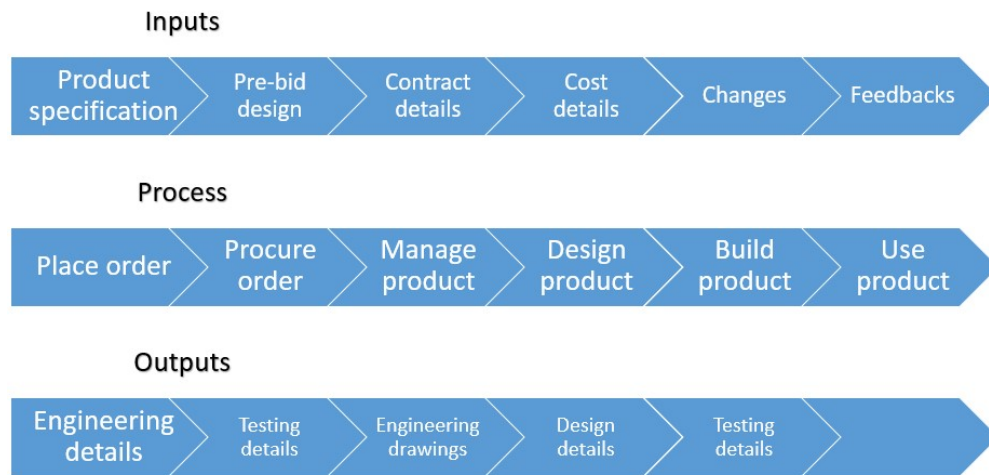


Figure 8. The general ETO process (based on Pandit and Zhu 2007).

As seen from Figure 8, the typical ETO process can have six major steps, (1) Place order, (2) Procure order, (3) Manage product, (4) Design product, (5) Build product (fabrication), and (6) Use product. The inputs and outputs from the figure should be emphasized because without the clear features the process cannot move forward.

It is argued that integration is always one of the key activities in ETO SCM (Mentzer et al. 2001). This implies the workers in the SC should work closely and collaboratively. Clearly, ETO SCM is excellent in performing the customized products. However, there are defects of the ETO SCM. For example, the most significant problem of ETO is long lead time (Pandit and Zhu 2007).

The procurement process is one of the most important part in ETO SCM. For example, it is presented that the procurement should be done in different phase during the process-bidding phase, basic designing phase and the detailed design phase (Pandit and Zhu 2007). In the other word, the ETO SC is involving in the bidding phase of the whole business process, this is before the SC get the order confirmation.

#### 4.2.3 Comparison of the ETO and MTO SCM

From the literature review, both ETO and MTO supply chain management require customization of products. Additionally, Handfield (1994) points out the differences between the ETO and MTO type of manufacturing (Figure 11). As shown in Figure 11, the ETO has longer lead time than the MTO SCM. Moreover, the MTO type of SCM requires more time in the design phase.

Related to some other phase, for example, business practitioners and scholars are aware of the importance of the planning in the supply chain. Especially for ETO type supply chain, since the lead time is always very long for the customized products. Figure 11 below highlights the major differences between the MTO and ETO process.

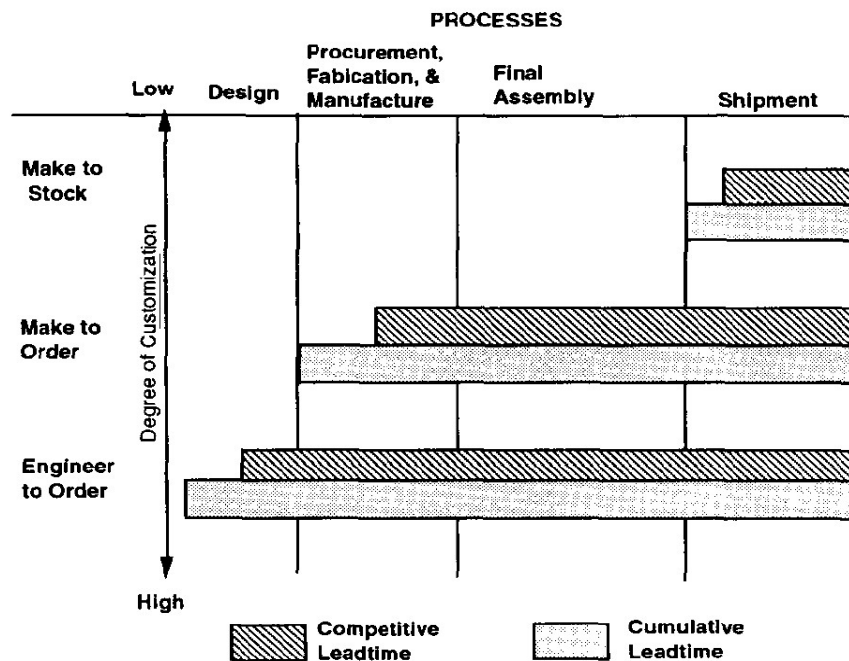


Figure 9. The delivery leadtime for different product type (Handfield 1994: 386).

Figure 9 shows the differences between the MTO SC and ETO SC practices. First, the ETO SC has longer processes-start from the “Design” phase, whilst MTO SC starts from “Procurement” phase. Secondly, compare with the MTO SC, the ETO SC has a higher “Degree of Customization”.

To visualize the differences of ETO and MTO SCs, the following figure shows the general process, structure and resource needs for both SCs which is tackled from Figure 7 and 8.



Figure 10. The simplified process comparison for ETO & MTO SC (based on Karim et al. 2008: 2391, and Pandit and Zhu 2007).

As Figure 10 shows, the ETO and MTO general process seems very similar, however, there are several evidences shown the differences: (1) ETO focuses on managing the product (e.g. manage product & Design product) versus. MTO focuses on inspection of the product (e.g. product inspection); (2) ETO uses the products after the manufacturing versus. MTO assembles the products after manufacturing. Except the visible items, the other perspectives show the similarities and differences of ETO and MTO SCM are shown in Table 7 below.

*Table 7. The differences and similarities from the literature for MTO and ETO SCM.*

	MTO SCM	ETO SCM
Type / Feature	Make-to-order (MTO) product is manufactured in order to meet a customers' requirement, and it is a type of process which there is little product variation (Handfield 1994)	ETO type of organization is the mass customizer (Haug et. 2009)
Starting point	SC order is starting to the manufacturing only after the company demand has been received in MTO SC (Youssef, Van Delft and Dallery, 2004)	SC order sometimes start in the bidding phase (Pandit and Zhu 2007)
key activity	To eliminate the non-value added activities as a key theme in the MTO SCM (Karim et al. 2005)	Integration is always one of the key activities in ETO SCM (Mentzer et al.2001)
Problems	MTO companies are rarely accurately forecast demand, order materials and produce in advance or effectively because of the customized products (Stevenson et al 2004)	The most significant problem of ETO is long lead time, the procurement should be done in different phase to shorten the lead time (Pandit and Zhu 2007)
	The problem occurs not because of the product but the company's operation mode (Jahnukainen and Lahti 1999)	Requires modification or develop completely new designs Products (Gosling and Naim (2013))
Focus	MTO SCM focuses on the process management	ETO SCM focuses on the project management
Others		The procurement should be done in different phase during the process-bidding phase, basic designing phase and the detailed design phase. (Pandit and Zhu 2007)

Summing up, the differences shown in Table 7 could be seen from three perspectives: (1) MTO SCM has low customized products vs. ETO SCM is a mass customizer; (2)

MTO SCM starts the order when the demand is recognized versus. ETO SCM is also involved in the bidding phase; (3) MTO SCM problems with the operation mode versus. ETO SCM's most significant issue is long lead time. It is important to notice the differences in order to harmonize the MTO and ETO SCM. These themes will be further utilized in section 5 when building the proposal.

### 4.3 Two Types of Organization Structure

The customer order management could be performed as ordering process and project management in an organization. Thus, it is important to understand the differences between these two customer order arrangement. In order to identify the distinction, this section introduces the organization focus from two perspectives: the project oriented focus and the process oriented structures. The following sub sections introduce the definition and features of the two types of organization structures and compare them in the summary.

#### 4.3.1 Project Oriented Organization Structure

The project-oriented company is defined as a company that have traditionally focused on product-centric project deliveries as their core business, and increasingly complementing their deliveries with different types of service offerings to create customer specific solutions (Kujala et al. 2012).

Companies are increasingly managing their daily work as a project management in order to achieve business goals (Hyvärä 2005). Thus, it is important to know the features of the project-oriented organization focus. For example, one of the papers argues that the number of project's strong stakeholders is important to the project (Artto et al 2007). Moreover, Kujala et al. 2012 present that the project-based company provides the tangible and intangible elements to the customer, which tangible implies the products or solution and the intangible means the service or solution.

Other than the features, it has been noted that the procurement is as important as other phases such as design and manufacturing in the project-based organization (Elfving et al 2005); in their paper, the author also argues that the work could be done in a parallel manner (shown in Figure 11 below).

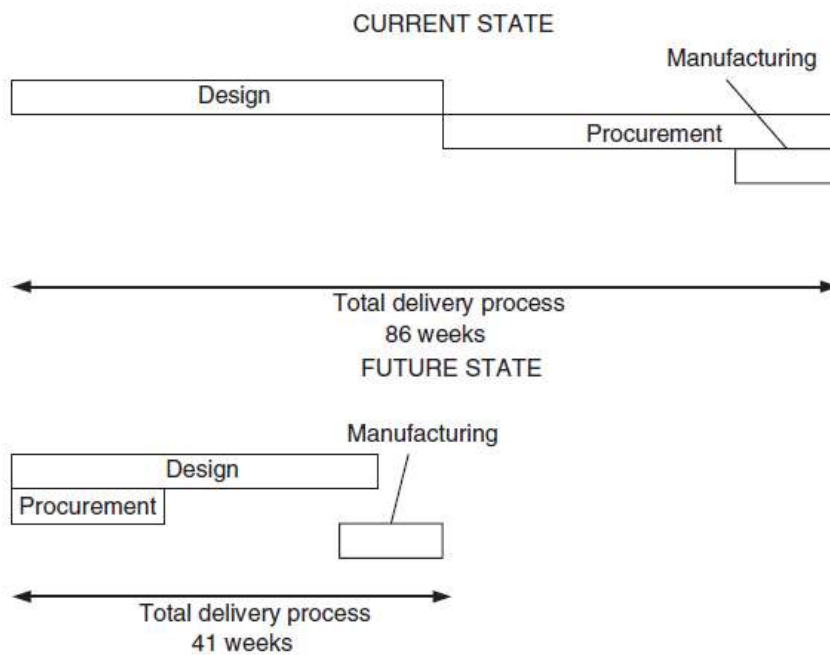


Figure 11. The procurement process for project-oriented organization (based on Elfving et al. 2005: 180).

As seen from Figure 11, in this example, before the design and the procurement process are linear and the process takes 86 weeks totally. However, after the design and procurement works parallel, the total deliver process is 41 weeks. Project-based companies are increasingly adding services to their offerings (Kujala et al. 2012). Clearly, the result emphasizes the advantage of the parallel works that shortens half of the total delivery time. In doing so, the parallel works requires upon on a lot of integration of the different parties.

#### 4.3.2 Process Oriented Organization Structure

The organization process is defined as pulling together absolutely everything necessary to deliver important component of strategic value (Hagel et al, 1993).

Most of the process-oriented organization hardly define the level of collaboration their employees should follow (Majchrzak and Wang 1996); in their paper, the disadvantages in process-oriented organization are pointed out: (1) The collaboration for the employees is not well defined, and (2) Repeat the same problems when there is no responsibilities overlap in process.

The resources need for the process oriented organization is well defined from the literature. First, the collaboration is in order to work together (Majchrzak and Wang 1996). Second, process owner leads the process development (Hammer and Stanton 1999). Third, organizational units are organized around core processes and other processes are modified based on the core processes (Vanhaverbeke and Torremans 1999). Fourth, the business units are doing things better with their own process or work but lacking of the knowledge of others processes or works (Ostroff and Smith 1992).

Understanding, analysing and solving make the process management steps to fix the gaps in the process. Hagel et al. (1993) discuss the way how to measure the process in the process-oriented organization: Firstly, understand the performance drivers and the performance targets; secondly, do the gap analysis; thirdly, identify the gap; finally, fix the gap. The detailed process as shown in the below table:

*Table 8. The process of approaching problems in the process-oriented organization (based on Hagel et al. 1993: 55).*

1.	Understand	"The performance drivers and the performance targets"
2.	Analysis	The gap. "Where am I today? Where I need to be? What obstacles are in the way of my getting there?"
3.	Solve	"What sources of leverage can I tap to overcome them?"

Except for fixing the problem in the process, another way of making the process better is *the process standardization* and diversity in the process-oriented enterprises (Hammer and Stanton 1999). Thus, Table 8 above could be used as a reference model in fixing the SCM gaps for the process occurred in Section 5.

#### 4.3.3 Comparison of the Project & Process Oriented Organizations

The key elements of the project-oriented and process-oriented companies are introduced in the previous sub section. As shown in Table 9 below, the key themes of the project and process oriented organization is compared from different dimensions.



*Table 9. The key themes of the Project & Process Oriented organization.*

		Project Oriented company	Process Oriented company
1	Definition	The project-oriented company is defined as a company that have traditionally focused on product-centric project deliveries as their core business (Kujala et al. 2012)	Organization process is defined as pulling together absolutely everything necessary to deliver important component of strategic value (Hagel et al, 1993)
2	Proposition	the number of project's strong stakeholders is important to the project (Artto et al 2007)	The collaboration is in order to work together (Majchrzak and Wang 1996)
3	Key item	Procurement is as important as other phases such as design and manufacturing in the project-based organization (Elfving et al 2005)	Process owner leads the process development (Hammer and Stanton 1999)
4	Structure	Project-based company provides the tangible and intangible elements to the customer, which tangible implies the products or solution and the intangible means the service or solution. (Kujala et al. 2012)	Organizational units are organized around core processes and other processes are modified based on the core processes (Vanhaverbeke and Torreman 1999)
5	Others	Work could be done in a parallel manner (Elfving et al 2005)	The business units are doing things better with their own process or work but lacking of the knowledge of others processes or works (Ostroff and Smith 1992)
			Most of the process-oriented organization hardly define the level of collaboration their employees should follow (Majchrzak and Wang 1996)

In summary, as well as shown from the table above, the major differences between the project and process oriented companies are from three perspectives: (1) Project-oriented company with product-centric to provide a better service to the customer versus. Process-oriented company with process-centric to pulling everything together, (2) Strong stakeholders versus. collaboration with different process blocks, (3) Parallel working manner versus. Core process with sub process. These themes will be further utilized in section 5 when building the proposal.

#### 4.4 Harmonization and Modularity

Nowadays many companies deal more with the increased customized requirements (e.g. customization products) and variations (e.g. order change requirement). In such, one type of SCM cannot handle the different level of customization products and uncertain variations. Thus, there should be a hybrid SCM to support this differences and uncertainty.

Generally, *harmonization* is an approach and a precondition for optimizing the business processes and performance (Michalik et al 2013). Based on the views of Norta and Eshuis (2009), one of the harmonization approaches is to perform the process dynamically. Similarly, in the SCM content, it is suggested that the approach to the improve SC performance is to perform hybrid strategies (Christopher 2000). As such, it could be argued that the one approach of the harmonization is to perform the hybrid SCM.

Additionally, the architecture of any product or process can be more or less modular (Voordijk et al 2006). Therefore, this paper supports the approach that the harmonized SCM could be managed through the SC modularity. Modularity is a strategy for organizing complex products and processes efficiently (Baldwin and Clark 1997). Another article also deals with the modularity from the service perspective by Bask et al. 2011, indicates that the modularity is one of the most important methods for achieving mass customization.

It is argued that the scope of the modularity is through the whole business process (Baldwin and Clark 1997). In the other words, the process can be modularized according to the business content. Moreover, the modularity can be categorized in three aspects: **services**, **processes** and **organization** (Perkkarinen and Ulkuniemi 2008). In order to adopt in the SC environment, the modularity should be managed through the whole SCM process (from the bidding phase to the logistics phase). For example, when the modularity is made for the whole SCM process, the services, processes and organization should be modularized according to the different modules

Furthermore, the modularity in SCM should be performed in three categories, the customer service, the processes and the organization. In the other hand, the modularity does not exist by itself, it requires the all the elements support each other (service,

process and organization). Thus, when doing the modular, all these three elements should be considered.

Summing up, Section 4 introduced and compared different types of the SCM and oriented organization. The overall aim was to provide a framework to harmonize the ETO project oriented SCM practices and the MTO process oriented SCM practices. Furthermore, section 4 also discussed harmonization through the lenses of SCM modularity in order to achieve a hybrid, modular SCM.

#### 4.5 Conceptual Framework

This study, based on the discussion above, can point to the following steps to harmonize, as well as control, the scope of the SCM process. This study chooses the modularity perspective as an approach to harmonize the SCM processes.

A harmonized SCM process could be managed through the SC modularity. Modularity is a strategy for organizing complex products and processes efficiently (Baldwin and Clark 1997). As such, the modularity of the SCM is managed from three perspectives: (a) the customer service, (b) the SCM process and (c) the organization. As business practice and existing knowledge suggests, it is important to select the supply chain type for the organization which includes the efficient & responsive process, customized & standard products (Fisher 1997). From the customer perspective, the efficient SC, in the other word, the agile & flexible SC, is able to service the customer more rapidly (Christopher and Towill 2000). Thus, *the hybrid* SC is more efficient from the organization perspective, and can provide a better customer service. However, agility or flexible should not be mixed up with leanness since lean is about doing more with less (Christopher 2000).

Figure 12 below merges the findings related to harmonization and modularity in SCM into the conceptual framework that could then help in guiding a harmonization of the SCM process through increasing the SC modularity for the case company.

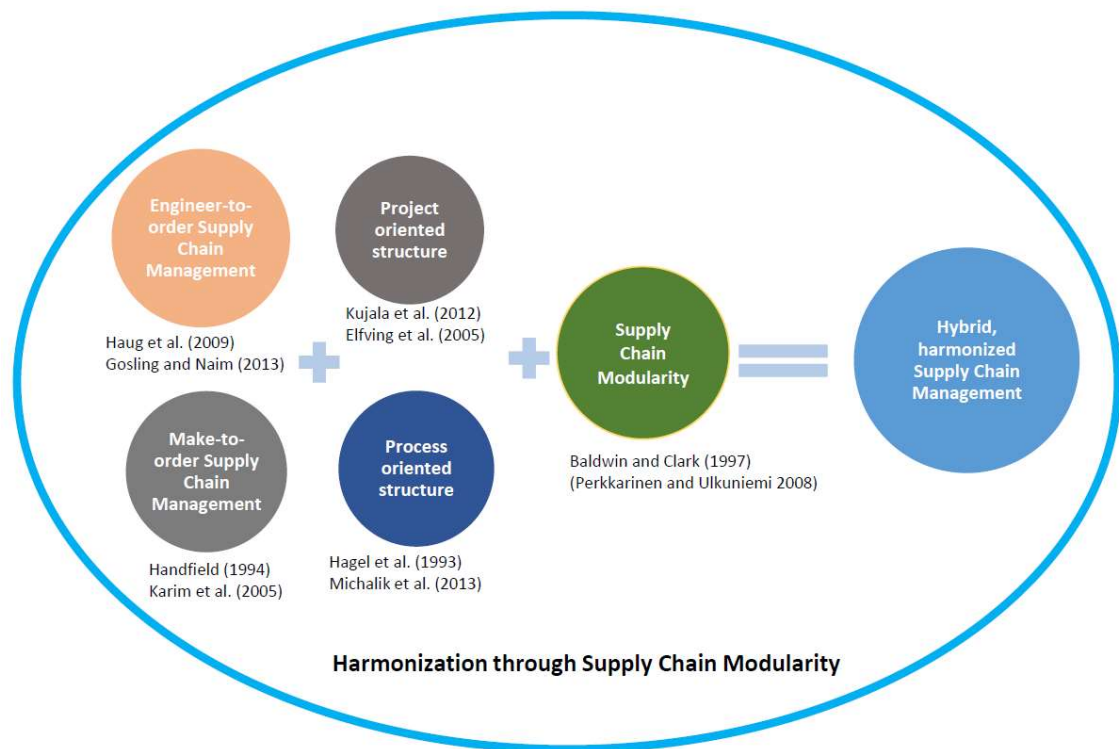


Figure 12. Conceptual framework of this thesis.

As shown in Figure 12, a harmonized process can be built on the modules established from four perspectives: (1) make-to-order SCM, (2) engineer-to-order SCM (3) process oriented structure and (4) project oriented structure. The approach of the harmonized process is the supply chain modularity.

From the existing knowledge and best practice related to (a) *Make-to-order process*, this study stresses the importance of production type, process focus and short order lead time. From the perspective of (b) *Engineer-to-order process*, this study stresses the importance of mass customization, early involvement and long lead time.

From the perspective of (c) *Process oriented structure*, this study stresses the importance of collaboration needs, identifying the gap and simple manner practices. Finally, from the perspective of (d) *Project oriented structure*, this study stresses the importance of product-centric, customer service and parallel manner ideas.

From the perspective of the harmonization approach, this study highlight that the modularity should be done through the whole process instead of some parts. Moreo-

ver, the study stresses the three major parts to be modularized - *services, processes and the organization*.

As a result of selecting these four perspectives, the CF of this thesis includes three parts and the sequence is presented as follow: firstly, the ETO SCM with mass customization, big cover of business process and project oriented structure. Secondly, the MTO SCM with some customization, shorter cover of business process and process oriented structure. Thirdly, to harmonize the different types of SCM with SC modularity approach to the hybrid, harmonized SCM.

In the next section, the study builds the proposal harmonized SCM for the case company using this approach to process harmonization.

## 5 Building a Concept for Both Supply Chain Units

This section builds the proposal for the case company based on merging the results of the current state analysis, findings from existing knowledge and suggestions from the stakeholders in the SC Project process.

### 5.1 Overview of the Proposal Building Stage

The proposal is tailored to meet the objective of this study which is to harmonize the SCM for the two SC units in the case company. First, the CSA scrutinized the current SCM practices of the case units into three aspects: 1. Organization structure, 2. SCM process and 3. SCM project resource. Thus directed, the study explored best practice related to harmonizing the SCM process and decided to approach it from the modularity perspective.

For building a harmonized process, the approach based on increased modularization was adopted. These modules were proposed to be established from four perspectives (as suggested in the CF): (1) make-to-order SCM, (2) engineer-to-order SCM (3) process oriented structure and (4) project oriented structure.

For the proposal building, the current SCM process was discussed from three dimensions (based on CSA). First, the proposal focused on the difference is between *too many checklists* and *too many process documents*. There were two group interviews done to discuss these challenges related to use of the current documents in the case company. Based on the results of this discussion, this study proposed how to harmonize and categorize the checklists and process documents into one format.

Second, the proposal focused on the difference between *the standardized process* and the very *flexible* process, which is very strong between the two units in the current SCM process. For this reason, the study proposed to modularize the process into a strict and a flexible process based on *the level of customization* and SC modularity.

Thirdly, the proposal focused on the difference between the *not enough integration* and the *strong collaboration* with different stakeholders, which is very strong between the two units in the current SCM process. Modularization for this difference is based on *the*

*process-oriented* and *project-oriented structure* (as suggested in CF), and the collaboration was proposed to match the level of customization for different types of products.

Further on, the proposal focused on *the organization structure* where there is a strong difference between the customer service/support function, which Unit A does not have, whilst unit B does have it. For this reason, the modularity in the level of customization was proposed to differ for (1) the high level customized products where the customer support is necessary, to (2) the mid-level, where the service could be needed, and (3) the low level products, where the service is not necessary.

These challenges addressed in the Proposal are related to the problems which were identified from the CSA. Table 6 below reminds about the finding from CSA (tackled in the proposal).

*Table 6. Key types of differences to be harmonized between Unit A and B (from CSA).*

1. Organization structure		2. SCM Process		3. SCM Project resources	
Unit A	Unit B	Unit A	Unit B	Unit A	Unit B
Does not have customer solution / service department	Has customer solution / service department	Many check-lists which do not support very complicate project	Many process documents	Lack of project handler	Many project handlers
Does not have process development department	Has process development department	Very strict, standardized process	Very flexible process	Not project oriented, e.g. normally no project chief designer	Clear project structure picture and support
		Not enough collaboration towards the different stakeholders	Strong collaboration towards the different stakeholders		

In addition, in relation to the *SCM project resources* (from CSA), the proposal also tackled the difference between the *not project oriented* and *clear project oriented structure* (as suggested in CF). Thus, the modularity for the process and project oriented structure proposed in the Initial draft below was made based on these reasons (as established from CSA and then investigated in CF).

## 5.2 Findings of Data Collection 2

The key theme conducted from Data 2 is shown in Table 9. During the meeting, it is discussed that there was a need for three categories when the company is doing the orders/projects from the customers based on the CSA and CF. From the literature discussed earlier, it was clear that the customization level (project complexity) as well as the products quantity are two most important measurements in the SCM. Therefore, these categories were discussed with the stakeholders and their definitions were proposed as listed in Table 10 below.

*Table 10. Categories suggested for the process flowchart of the draft proposal.*

	Project Customization level (complexity level)	Category		Best practice (identified from CF)
		Modified components	New design components	
1	High	Large quantity	Medium-large quantity	ETO SCM, Project-oriented structure
2	Medium	Medium quantity	Few	ETO SCM, Process-oriented structure
3	Low	Few -medium quantity	No new design	MTO SCM, Process-oriented structure

As seen from the table above, there were three customization levels proposed for the order/project-high, medium and low. The initial proposal to support these three categories combines the different themes of MTO SCM, ETO SCM, process-oriented and project-oriented structure.

The other important points from Data 2 collection are that the company is currently developing the harmonization practices for the whole business process. Therefore, the interface between the SCM with other departments should also be considered in the initial proposal.

Table 11 below shows the suggestions from stakeholders for the harmonized proposal.



Table 11. Suggestions from stakeholders for the harmonized proposal. (from Data 2)

	Issue related to	Suggestions, Data 2
1	Organization structure (from CSA)	"We have to make process improving in xxx (Unit A)
2		"Every complicate project needs support"
3		"We can build the process based on the complexity"
4	SCM process (from CSA)	"The process is the project based things, we could categorize the process"
5		"The FL is also a very important part in the process"
6		"We can share the time and resource for both xxx and xxx (Unit A & B)"
7	SCM project resource (from CSA)	"In xxx (unit B) you own the project, the SCM need early involvement in the project"
8		"In xxx (Unit A) the process is Day-to-Day the same, our order is always 'surprise order'"

As seen from Table 11, the stakeholders gave many suggestions for the building of the draft proposal. One of the stakeholders made a key suggestion that the process could be built based on the order/project complexity: *"We can build the process based on the complexity"*. Moreover, from the SCM process perspective, one of the stakeholders suggests that *"The process is the project based things, we could categorize the process"*. Finally, for the SCM project resource perspective, it was also suggested that *"the SCM need early involvement in the project"*.

Next section illustrates the draft proposal which is built based on the CSA, CF and Data collection 2.

### 5.3 Draft Proposal for the Project Process for Units A and B

This SCM process combines and harmonizes the current process and breaks them into three levels of modules based on the complexity. The proposed SCM process flowchart is shown in Figure 13 (SCM process flowchart).

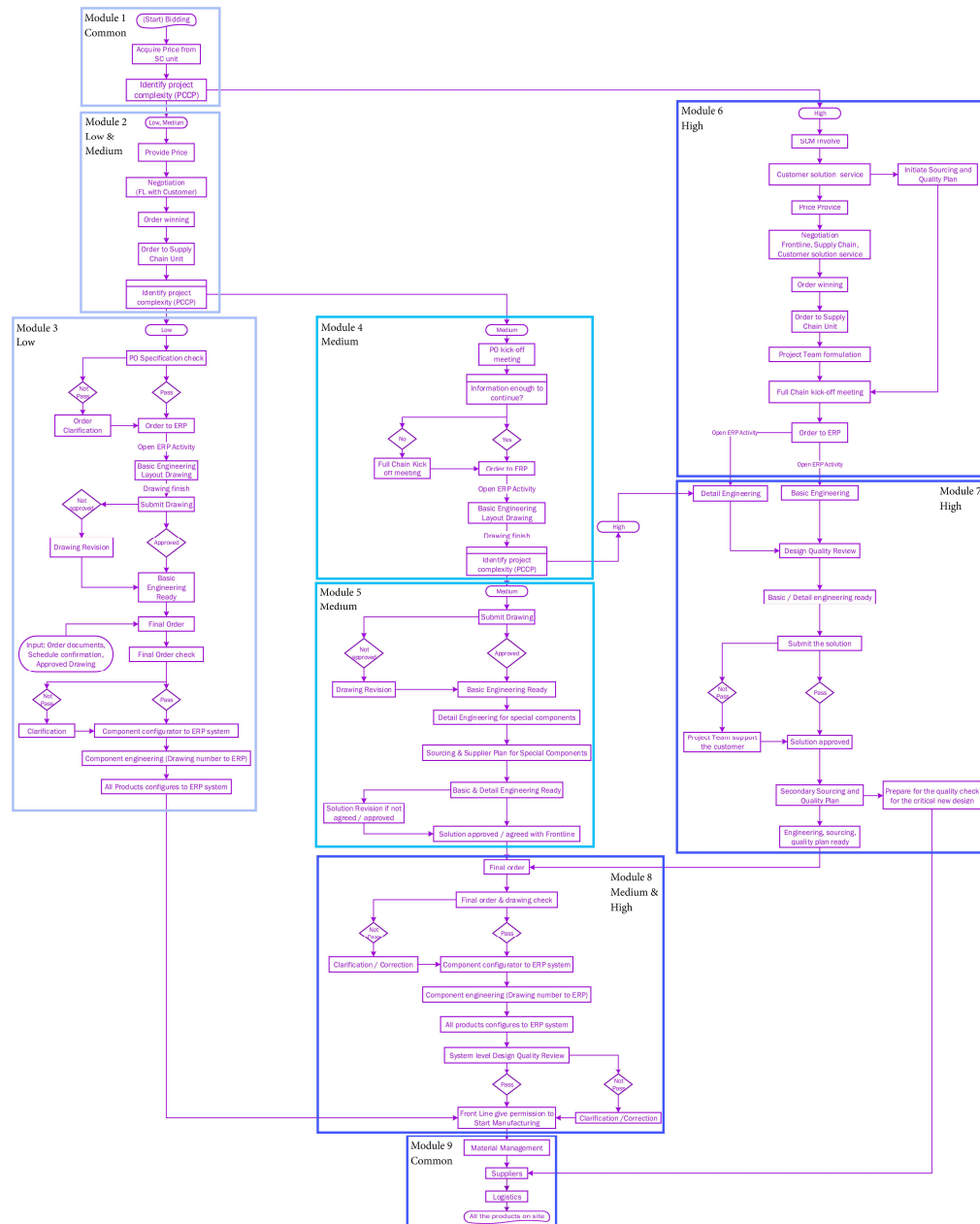


Figure 13. The draft proposal of the SCM process.

As shown in Figure 13, the link between the different modular is the Project complexity check point (PCCP). The PCCP in the process plays an important role. Because once the complexity level has been identified, the focus of how to proceed the project/order is confirmed.

As seen from Figure 13, there are three PCCPs. The first one appears after FL acquires prices from SC. In this phase, the process is divided into two ways-the Low & Medium and the high modular. The second one happens after order to SC unit. In this phase, the process separates the low and medium to two different modular. The third one is a bridge from the medium modular process to high modular. Because after the Basic engineering is done, the requirements could be high based on the findings from the Basic engineering.

#### 5.3.1 Common Module (Module 1)

The proposed harmonized process starts with *the Bidding*. In this phase, the FL representative Requires the project tender price form the SC unit. The input in this stage is the technical documentation from the FL. *Module 1* for the start of the process is shown in Figure 14 below.

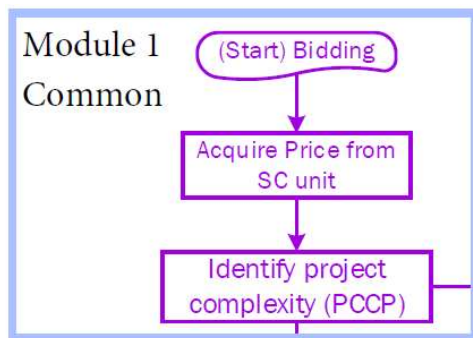


Figure 14. Module 1, Common module-from Bidding to first PCCP.

The next step is the first Project complexity check point (PCCP). In this stage, SC engineers and FL representatives check the specification from the customer together. When checking the complexity of the project specification, the process flow may go either low & medium or high module process. One reason for having two modules here is to allow the FL team has support from SC unit in the beginning when the project is very complex. With the support from SC during the tendering phases, it could strength-

en the knowledge of the whole team, because normally SC team has the technical knowledge which FL team does not have. This supplementation increases the opportunity for the company to win the order from customer.

### 5.3.2 Low and Medium Modules (Module 2)

For low & medium level project (order), the process shares the same module before order to SC. In this period, the SC Provides the project tender price to FL. FL Negotiates the project details with the customer until the company Wins the project contract. *Module 2* is shown in Figure 15 below.

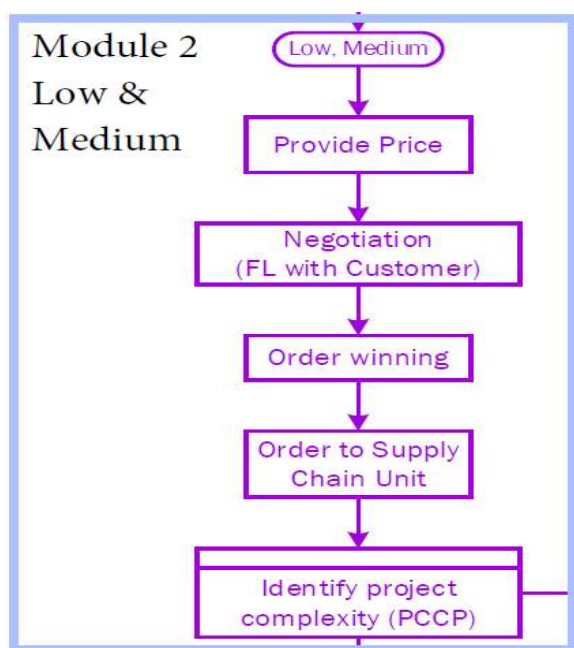


Figure 15. Module 2, Low & Medium – From provide price to order to second PCCP.

As seen from Figure 15 above, the low and medium level project start using different modules from the second PCCP. In the other word, the process flow is divided to low and medium module after the SC unit gets the order. Next sub-section explains the low level module.

### 5.3.3 Low Module SCM Process (Module 3)

As the order complexity being identified in the low category, the low categorized process modular is discussed below. *Module 3* is shown in Figure 16 below.

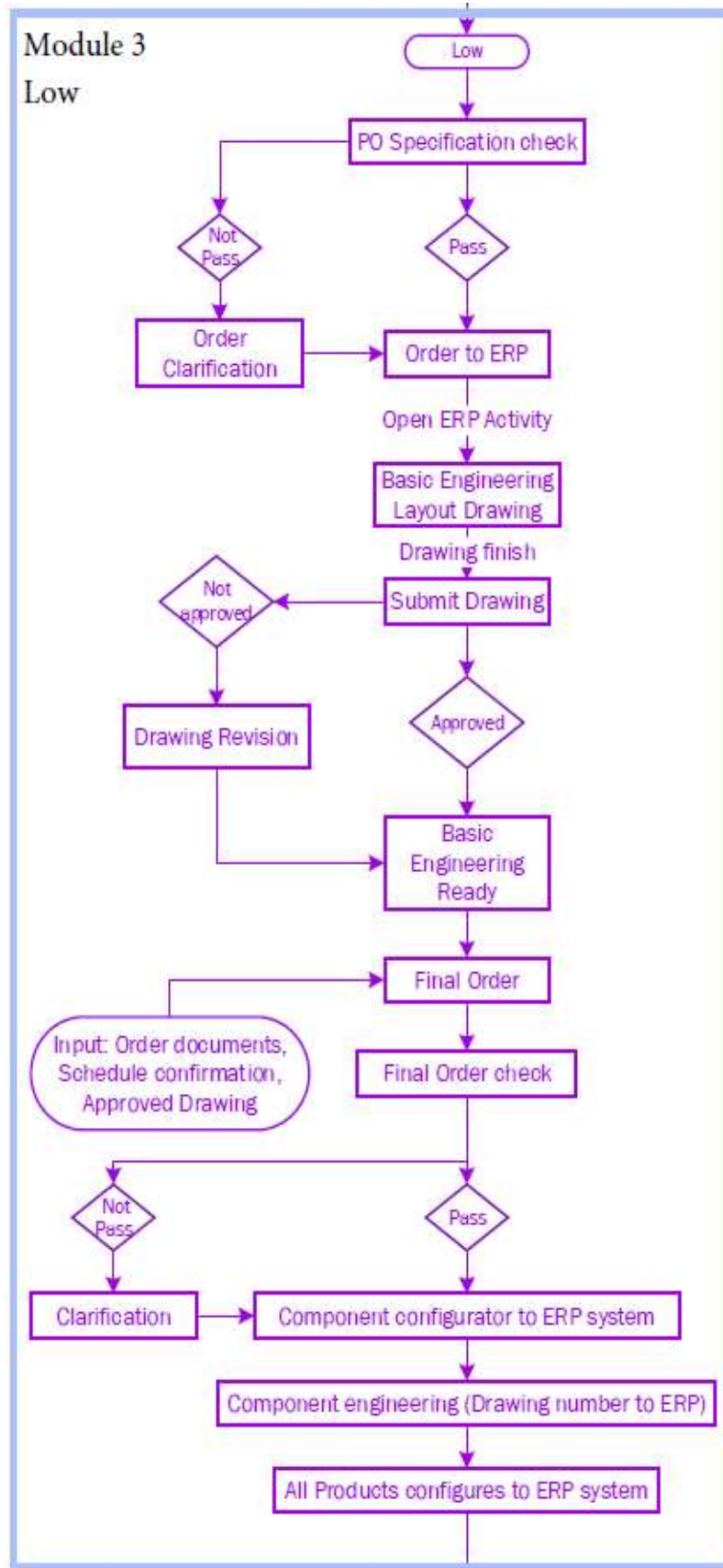


Figure 16. Module 3, Low category SCM process.

Figure 16 illustrates the steps from the Order to SC nit to All products configures to ERP. In this module, it is the PE or SM's responsibility to ensure the purchase order (PO) specification to ERP, Basic engineering done according to the PO, All production information in ERP, and the PO correction between engineers and FL.

The first step in Module 3 is to check the PO specification which is from the FL. The tool used here is a checklist. PE checks the PO and fill in the checklist during the checking period. If there is something wrong or unclear in the step, PE will clarify the issues with FL.

When all the checks have been done and passed, PE will open the PO in ERP and input the PO specification in there. The important here is to make sure the information is correct based on the PO. After the ERP has been opened, the activities are all made in the ERP system as shown in the appendix 4.

The third step is to Open the ERP activity to require the Basic engineering from the engineering department. The Basic engineering means to make the system level drawings such as the building layout drawings, the details components are not shown in the Basic engineering drawings if the components are very special (need to be customized). It is PE's responsibility to ensure all the information (input) is correct in ERP in this step. Engineer will finish the engineering according to the input from PE in ERP.

When the drawings are finished, engineer saves them in the case company Product Data Management system (PDM), confirms the ERP activity and notifies PE that basic engineering is done.

PE will send the notification to FL that the basic engineering has been done. In this step, FL takes the responsibilities to confirm the drawings with customer. Because once the drawings have been approved by the customer, they will be one part of the final order documents. It is important to make sure the drawings are correct.

When the customer confirms the Basic engineering, it means customer agrees that the SC unit could produce all the order components based on that. When FL gives the Final order to SC, it should include (1) order documents, (2) schedule confirmation, and (3) basic engineering confirmation.

After FL sends the Final order to the SC unit, the PE will check if the configures are the same between the order documents and basic engineering. Additionally, all the order related documents should be saved in PDM. This procedure ensures the information transparency and availability to all the stakeholders.

When all the order documents are ready under the PDM, PE opens the ERP activity to request the engineering department to list the components in ERP. The input data in this stage from PE is all the correct final PO related documents.

Next step is the Component configures to ERP. This step basically means that all the final order documents are input to ERP. So ERP will have all the PO information such as components drawings, dimensions, materials and quantities. These correct information ensures the purchasing department (Material management in the process map) to have the correct information send to suppliers. In addition to transferring the PO into ERP, the listing engineer also opens the engineering activity in order to get the information which ERP does not provide. For all the configures, ERP has a range for listing engineer to choose. When the products are extended certain range, it means that the products will be either modified based on the existing product or totally new design. Then the engineer will open the ERP activity accordingly in order to get the configures from the engineers such as mechanical engineers, electrical engineers and software engineers.

In the component engineering stage, the engineers are responsible to check the requirements from the listing stage. The engineers in this step is going to check the empty ERP configures, make the drawings or select it from the case company engineering bank. Finally, All the configures are in ERP regarding the PO. In the next step all the three complexity modular will share the same process flowchart (Module 9), it will be introduced when all the three levels are discussed.

#### 5.3.4 Medium Module SCM Process (Module 4, 5, 8 and 9)

The medium process consists three parts, (1) From PO kick off meeting to Basic engineering, (2) From Basic engineering to final order, (3) From Final order check to FL gives permission to start manufacturing, and (4) From Material management to all products on site. The step 3 is the common module for medium and high categories,

the step 4 is the common module for all categories and it is discussed in this sub section.

#### I. From PO kick off meeting to basic engineering

As seen from Figure 17 below, the first step is PO kick off meeting. In this step, the tender engineer is responsible to hold the meeting with PE. Additionally, PE is in charge of the communication between the FL and SC. During the meeting, the tender, tender engineer should tell what has been offered to the FL during the PO tender phase. *Module 4* is shown in Figure 17 below.

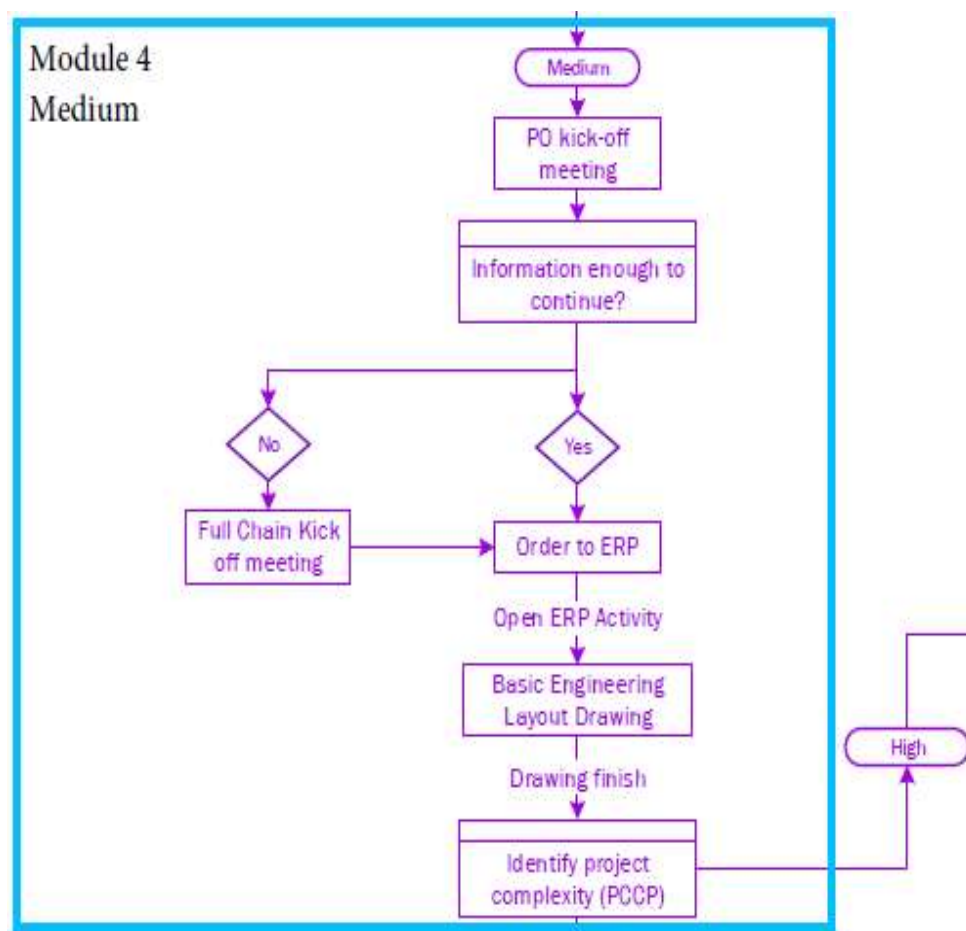


Figure 17. Module 4, Medium-from PO kick-off to Basic engineering.

After knowing what has been offered to the FL, PE will check if the information is enough to continue the order processing. The sufficient information includes the order document, the things have been provided/promised to the customer, the requirements, and the special concerning from the customer.



When the information is enough, PE will input the PO specification to ERP. This operation is as same as in Module 3. If the information is not enough, then the Full chain kick-off meeting should be held. The Full chain kick-off meeting is to tame up the stakeholders, enhance the collaboration and clarify/correct the PO specifications at the first place.

The next step PE opens the ERP activity to request the Basic engineering. The process after the Basic engineering may go to two different modules. One is the module that complexity keeps medium. Another possibility is the complexity will become high because the engineer can identify a lot of unmet modified or totally new products during the Basic engineering process. This shows the dynamic of the modular process and it is also the link between medium and high modules.

When the engineer finish the Basic engineering and the PO complexity remains to be medium, next step will be PE submit the drawings to FL as Figure 18 shows below.

## II. From Basic engineering to Final order

If the complexity remains to be medium, the process flowchart goes as shown in Figure 18, next page. In this module, after PE submits the drawings done by the engineer to FL, FL will discuss the drawing with the customer. The Basic engineering done means the drawings are approved from customer or FL, and it could be done through some drawing revisions in SC.

The next activity is to Make the detailed engineering. The approach is that PE opens the activities in ERP. The Detailed engineering means to require the solution or drawings for the customized products in PO which is identified earlier from customer, tender and basic engineering. This ensures that all the solution and customized products is confirmed and made before the final order. Moreover, it avoids the uncertainty appears in the late phase.

*Module 5*, from Submit drawing to Solution approved with FL, is shown in Figure 18 below.

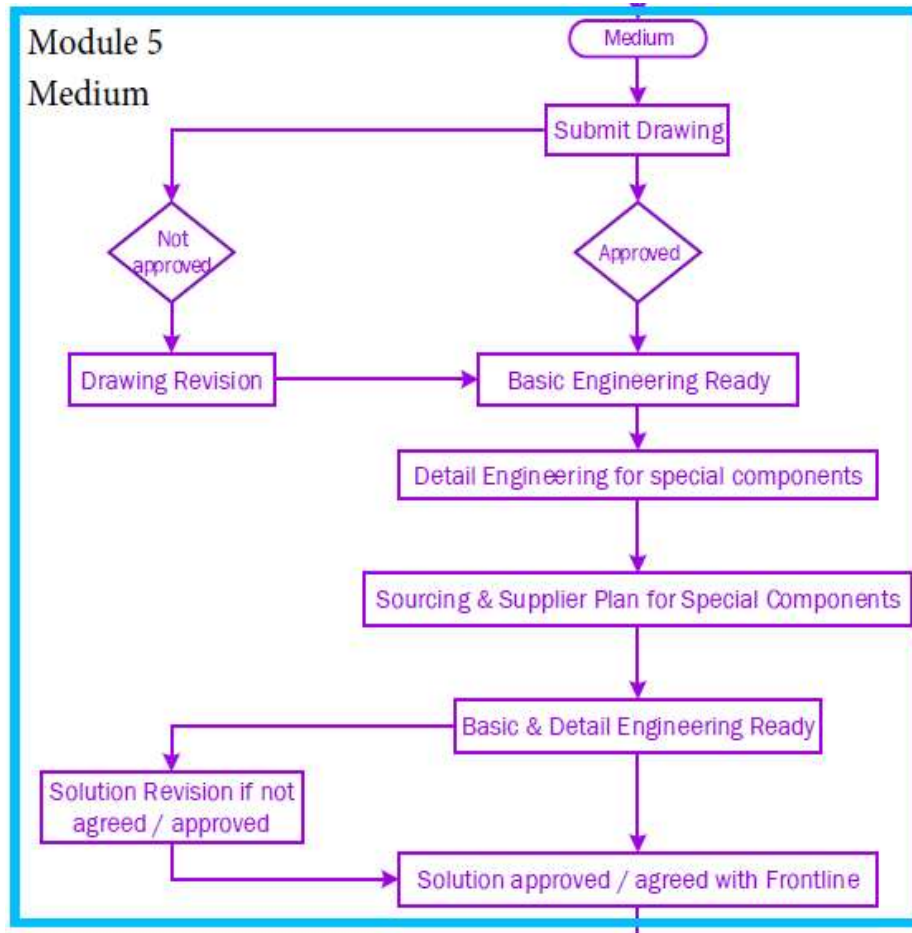


Figure 18. Module 5, Medium complexity - from Submit drawing to Solution approved.

After the Basic engineering is ready and the Detailed engineering is done, first PE will make the Sourcing plan to decide where those customized products will be purchased. Then PE will communicate the solution and customized products with the FL and customer. Here highlights the collaboration among the stakeholders, because the detailed engineering drawings might affect customer's other products in the building. If the customer does not like or agree with the solution, there will be some revisions done in collaborated with the customer. The outcome of it is to get the Basic & Detailed engineering agreed with the customer before the Configures to ERP.

As such, the Final order consists the order documents, the Basic & Detailed engineering approved and Sourcing plan for the customized products. The next phase is the joint venture for medium and high modules.

### III. From Final order check to FL gives permission to start manufacturing

The medium and high modules will join together after the final order (as seen from the figure below).

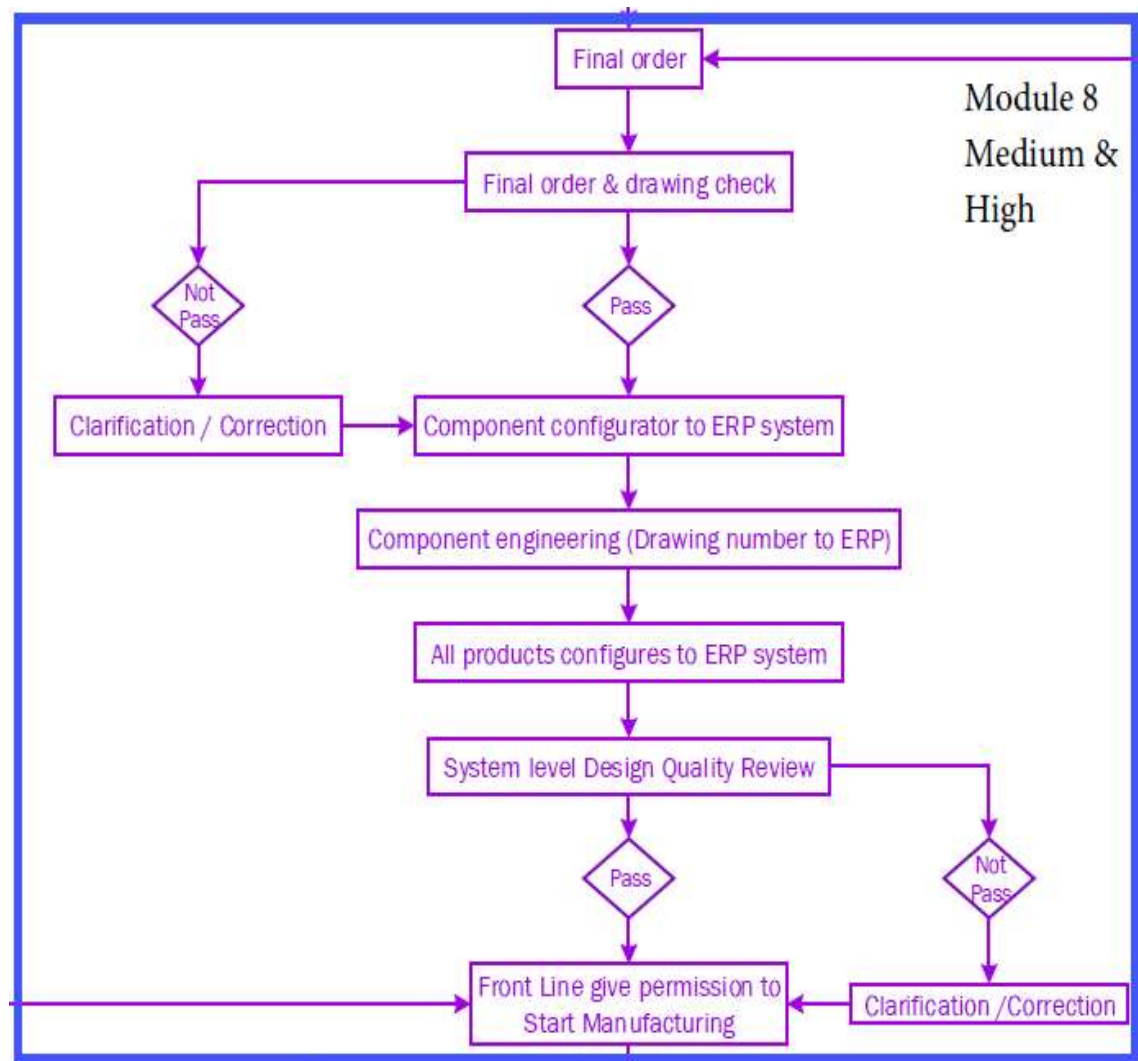


Figure 19. Module 8, Medium & High-from Final order to Permission to manufacturing.

The process flowchart follows as same as the low module (Module 3) from Order check to All products to ERP. The different part is before the FL gives permission to start manufacturing. There is System level design quality review, as Figure 19 shows. The Design quality review is to let engineers check the interface for the components they have designed in the system level. This is because for Medium & High modules order/project there are quite large amount of modified and new designed components. This allows the engineers to make sure that all the components work together on the

system level and gives opportunity to make correction before making any mistakes in the manufacturing. However, the Design quality review is only meaningful for the Medium & High modules. The reason is for low module most of the products could be chosen from ERP system. The ERP system has automatically checked the interface already, another interface checking by engineers is unnecessary.

#### IV. From Material management to All products on site

This phase (Module 9) is the common module for all categories.

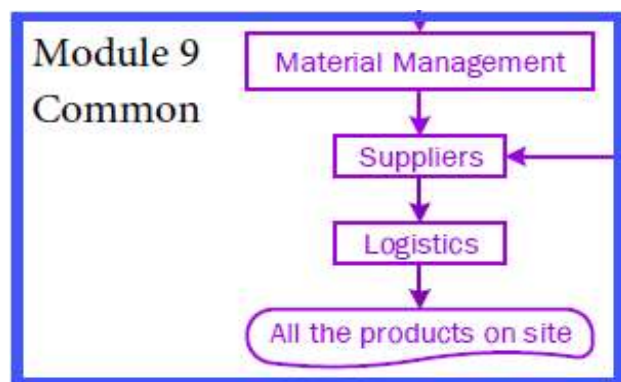


Figure 20. Module 9, Common-from Material management to All products on site.

When All the products/components information are ready in ERP, the next step is shown from Figure 21 that the purchase orders will be sent to the suppliers from the Material management department. The material coordinate ensures to make the correct supplier PO based on the information given from ERP.

The next step is Supplier manufacturing, the way to proceed the PO is slightly different between the low & medium and high modules as shown from the initial proposal map. From high module there is an arrow from the high module that the supplier will measure and test the components based on the quality test document made by the company. For low & medium normally, the suppliers follow the PO specification and drawings.

After the components finished, they will be delivered to the company distribution center. Next step the materials will be sent to the site and the SCM process is officially end here.

### 5.3.5 High Module SCM Process (Module 6 and 7)

From Module 1 after the FL requests the price from SC, it may separate to low & medium or high modules. This sub section presents the high module SCM process from beginning in the tendering phase to Final order as Figure 22 shows. The stage after the final order is same as the medium module.

The high module consists four parts. (1) From SCM involve in tendering phase to order to ERP (Module 6), (2) basic & detailed engineering to engineering sourcing, quality plan ready (Module 7), (3) Final order to permission to manufacturing (Module 8), and (4) material management to all products on site (Module 9).

#### I. From SCM involve in tendering phase to Order to ERP

The high module starts from the Module 6, and the process in Module 6 is shown in Figure 21 below.

The first step is SCM involve in the tendering phase, this way differs from the other two different modules. The SCM involves in the earlier project stage highlights the support from SCM. It is because in high category project there are a lot of modified and new designed components, this basically means the offer content will be provided to the customer is currently out of the company scope.

With the support from SCM in the beginning there are following benefits. First, the company can provide more competitive solution with the collaboration between the FL & SC organizations. Secondly, SCM colleagues could provide the valuable information to the FL which increases the possibility to win the order. Thirdly, it simplifies the process by working in the common target in the beginning. For example, the SC could save the time to have PO kick-off meeting because everyone has been working from the tendering phase and know what has been promised and offered.

The process in Module 6 is shown in Figure 21 below.

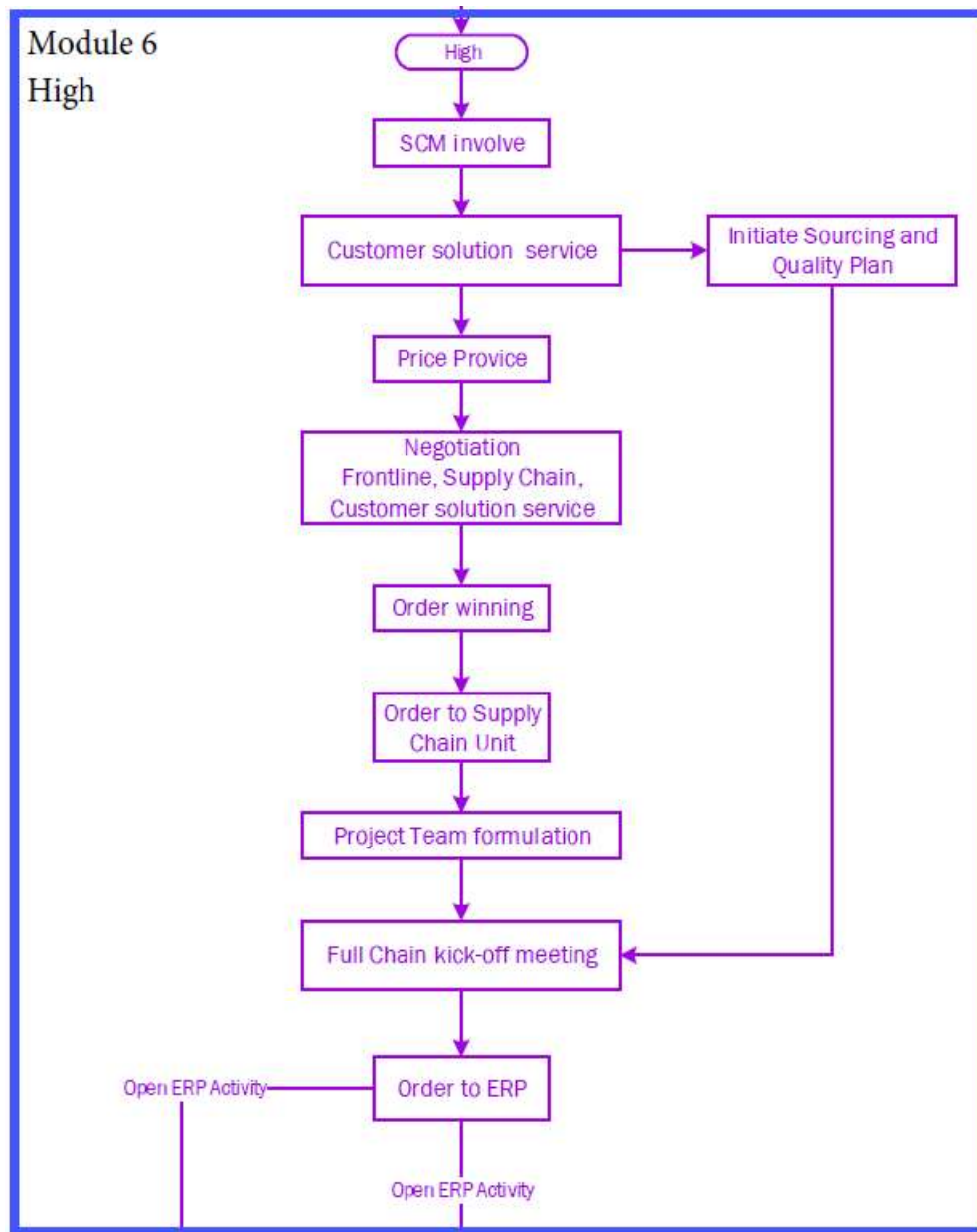


Figure 21. Module 6, High-from SCM involve to Order to ERP.

After the SCM involve step, the Customer solution service will be provided. This means that the company would provide the solution to the customer. In this stage, the Material sourcing plan for the components will be initiated, it is because (1) save the purchasing cost for some components material in order to lower down the offer price, (2) enable to provide a competitive materials leadtime by informing supplier in the very early project stage, and (3) give enough time for the product development by making long term plan for the customized & new design.

Next step SC provides the price including the solution to the FL, then FL makes the offer based on the SC price to the customer.

After that the FL & SC employees will Negotiate the price and solution together with the customer, in order to provide a better service and have more chance to win the project order. This step differs from the other two categories that FL negotiate the contract alone with the customer.

When the order is officially giving to the SC, the first step for the PE to do is to Formulate the SC project team which includes tender engineers, project chief designer, different component engineers and so on. The project team enable the common understanding and set same target to make the project successful.

Next procedure is to have the Full chain kick-off meeting. The Full chain kick-off meeting is a good chance to review what is the target of the project, risks and making activities. After the meeting, PE makes the order to ERP.

## II. From Basic & detailed engineering to Engineering sourcing, quality plan ready

The high module continues with Module 7 from Module 6 and the process in Module 7 is shown in Figure 22 below.

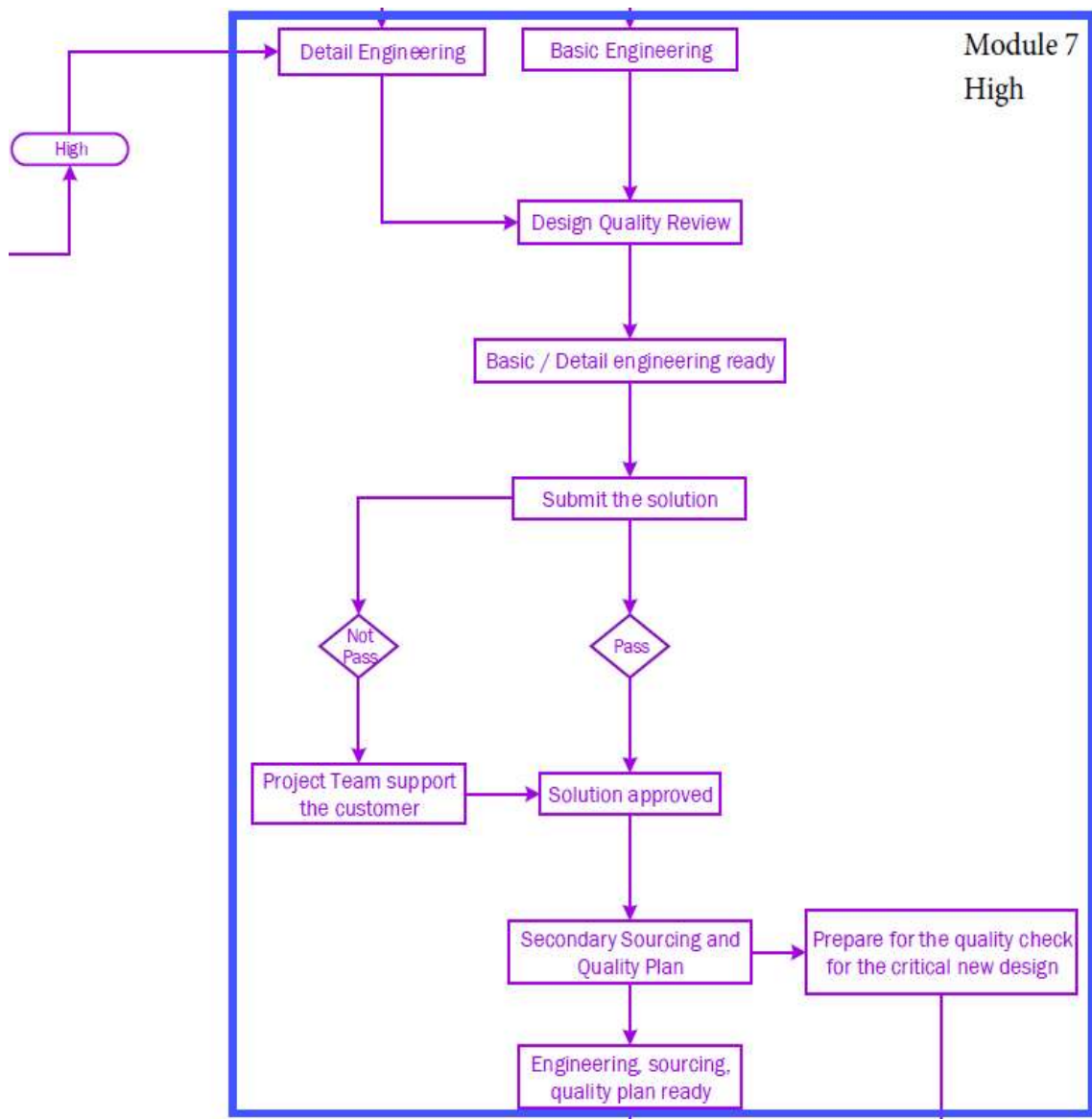


Figure 22. Module 7, from Basic & Detailed engineering to Engineering sourcing, quality plan ready.

The reason for separate the high module is because there is a link between the medium and high modules. As figures above shows, the medium modules can utilize the high module by jumping the process to from Module 5 to Module 7.

After PE inputs the order to ERP, both Basic engineering and Detailed engineering will be opened simultaneously in ERP by PE as well. This is because there are many new designed products in the Basic engineering which means it is hard for engineer to ensure the correctness of the Basic engineering. Because Basic engineering means put the existing components together in a set of drawings, if there are customized products, the engineer will just draw a sketch and the customized products will be made



and confirmed through the Detailed engineering or Component engineering in Module 8. By leveraging the simultaneous engineering, the Basic engineering will be finished faster and more accurate.

When the Basic & Detailed engineering is done, the first Design quality review will be held. Because the engineering is done simultaneously, the Interface check meeting could make sure the designs are correct from the project system level. The Detailed engineering block is also the bridge from the Module 5 (Medium module).

PE will Summarize the engineering solution to the FL after the System level interface being checked. Next step is FL submits the solution to the customer in order to get the solution approval. It is highlighted here that the FL & SC project teams work together, explain the details to the customer during solution negotiation with customer. This is because there are many designed products which may affect customer.

After the Solution being approved by the customer, there will be a secondary Sourcing and quality meeting which is based on two perspectives, (1) Initiated sourcing and quality plan in the tendering phase, and (2) Basic & detailed engineering (customized components). The customized component sourcing plan will be reviewed and to identify if there are critical quality components. The updated forecast is also done in this step in order to make sure the adequacy of the materials.

There are two outcomes after the sourcing quality meeting. First is the engineering, Sourcing quality plan ready, this facilitates the project and make sure the component correctness before the final order. Secondly, there will be quality check document made together with the suppliers and inform suppliers for the very critical & special items. This information is to ensure the price and quality confirmation with the suppliers to avoid the time waste in manufacturing stage if there is anything wrong with the components.

For the high module, FL provides the final order includes medium category documents and the customized components engineering forecast with suppliers. After the final order, the process flowchart is the joint venture with the medium module and discussed in the medium category module.

### 5.3.6 Harmonized Documents for the New SCM Process

The process documents are collected and harmonized in order to match the harmonized SCM process. In addition, the process documents are well supplement for the draft proposal. The categories for the documents are co-created through the group discussion in the case company.

*Table 12. Document categorize based on the customization level for both units.*

Stage	Document	Category	Low	Mid	High
1	Major project notification	All	x	x	x
2	Order check document	Low	x		
	Start-up meeting Procedures-Consist	Low	x		
	Sourcing and logistics plan	High,Mid		x	x
	Sample process	All	x	x	x
	Project name input data	Reference			
	Engineering category lead time	Mid, Low	x	x	
	S-Plan Map	All	x	x	x
	Use of SAP engineering status check	Reference			
	Internal SUM-engineering, special solution	High,Mid		x	x
	Full chain start up meeting	High,Mid		x	x
3	Transfer price	High, Mid		x	x
	Document issue register (DIR)	High, Mid		x	x
	Delivery group plan	High, Mid		x	x
	Sourcing and logistics plan	High, Mid		x	x
	RISK ANALYSIS INSTRUCTION	Reference			
4	Document issue register (DIR)	High, Mid		x	x
	Sourcing and logistics plan	High, Mid		x	x
	Drawings review (Current missing)	High			x
5	Final order check	All	x	x	x
	Listing and component start-up meeting	High, Mid		x	x
	Project nameInput Data	Reference			
	Final CSP	High, Mid		x	x
	S-PLAN MAP	All	x	x	x
6	Design quality review	High, Mid		x	x
	Material Lead times	All	x	x	x
7	FL give No Return Point	All	x	x	x
8	Mock up process	Only if required			

As table 12 shows, there are three categories for the documents. And the documents are linked to the case company project whole life time. For the low category, there are 11 documents which are used during the process. For the medium category, there are

20 documents are used during the process. For the high category, there are 20 documents are used during the process.

#### 5.4 Summary of the Draft Proposal

The draft proposal is built based on the current stage analysis, findings from literature and the group discussions from Data 2. Building the draft proposal involved the project handlers in Unit A, Unit B and the case company program manager in order to get comprehensive ideas. The draft proposal differs from the current practice as summarized in Table 13 below.

*Table 13. Proposed SCM modularity based on the current state.*

1. Organization structure			
Module	Low	Medium	High
Customer solution service	No	No	Yes
2. SCM Process			
Module	Low	Medium	High
Check lists	Yes	Yes	Yes
Process documents	No	Yes	Yes
Strict, stand process	Yes	Yes	No
Flexible process	No	No	Yes
3. SCM Project resource			
Module	Low	Medium	High
Project structure	No	No	Yes

As can be seen in Table 13, the draft SCM process provides the clear picture for the harmonized modules and tells the focus area for different modules. From the CSA the organization structure, SCM process and SCM project resource are sorted based on the different units. The new harmonized process modularizes and categorizes them into three modules based on the project/order complexity level.

Next section validates the draft proposal and proposes the final harmonized SCM process.

## 6 Validation of the Proposal

This section finalizes the proposal for the modular harmonized SCM process based on the feedback given by the management, key stakeholders and project handlers.

### 6.1 Overview of the Validation Stage

In this study, the validation is proved from three perspectives, the project director who is leading this harmonized SCM process, the key stakeholder who has been working for both case units and the SC manager who is not aware of this project.

The validation started with the introduction of this study. This study focused on the SCM. First of all, the business problem is defined by the company management team, therefore the same management stakeholders were involved in the validation stage. Secondly, the study made part of the ongoing project in the case company rethinking its whole process of the project management, when the study focuses on the SCM only. This means again that the management participation in the validation stage was grounded. Thirdly, the current state analysis was also revised focusing on the challenges identified in the current SCM in project management. Finally, the proposal of the new SC harmonized process proposes a harmonized SCM process for the two SC units in the case company. Therefore, not only the proposal but also the prospects for implementation of the new process were discussed for the management approval and taking a longer period perspective to the discussion on the results.

The findings from Data 3 collection from the validation stage are discussed next.

### 6.2 Findings of Data Collection 3

Table 14 illustrates the feedback from the management, key stakeholders and SC manager.

*Table 14. Summary of Data 3: Feedback for the initial proposal.*

	Position	Feedback
1	Program manager	To simplify the process flowchart
		The categorizes can be taken away
		Link the SCM process to the Project level
2	Key stakeholder	The three level of modular is same as we have been discussed, it looks good to me"
3	SC Manager	"The flowchart looks good, it makes sense to me, this is definitely what we should do""

As seen in Table 14 above, the stakeholders in the validation discussion gave a number of suggestions how the initial proposal can be further improved. The feedback is from Program manager, Key stakeholders and SC manager.

First, the Program manager wants the final proposal to be simplified and make it easy to read and understand, because the draft proposal process was considered too difficult to read. Moreover, the management suggests that the category could be taken away from the draft proposal so the different modules could be chosen from the project team. Furthermore, since the SCM process is part of the project main process, the management asks to write the final proposal under the project main structure.

Second, the draft proposal was shown to the project key stakeholders. As his opinion, the three level of modular is same as the project team has been discussed, and the process looks good to him.

Third, the draft proposal was presented to one of the SC manager, he thought the draft proposal makes sense to him and it is definitely what the SCM process should be.

Overall, as feedback to the proposal, there were three key suggestions made by the Program manager. The stakeholders and SC manager seemed satisfied with the initial proposal. Therefore, the final proposal is built based on the feedback from management stakeholder for the three perspectives as shown above in Table 13.

As seen from Table 14, the improvements for the final proposal are summarized from three perspectives. First, the SCM process flowchart is linked to the project main struc-

ture which is shown in Figure 2 and Figure 4. This enable the case company could use the SCM process from the project full chain perspectives. Moreover, the project stakeholders could have a better understanding of the SC process.

Second, the process flowchart is simplified and the PCCP is not shown in the final proposal. This improvement makes the process flowchart looks more simple and easier to read.

Finally, the differences between the final proposal and the current process (discusses in Section 6.3) is marked as Figure 23 shows. This highlight what has been improved and what is new according to the old process.

### 6.3 Final proposal for Supply Chain Process for Both Units

Based on the feedback in the validation session, the final version of the SCM process was created as shown in Figure 23.

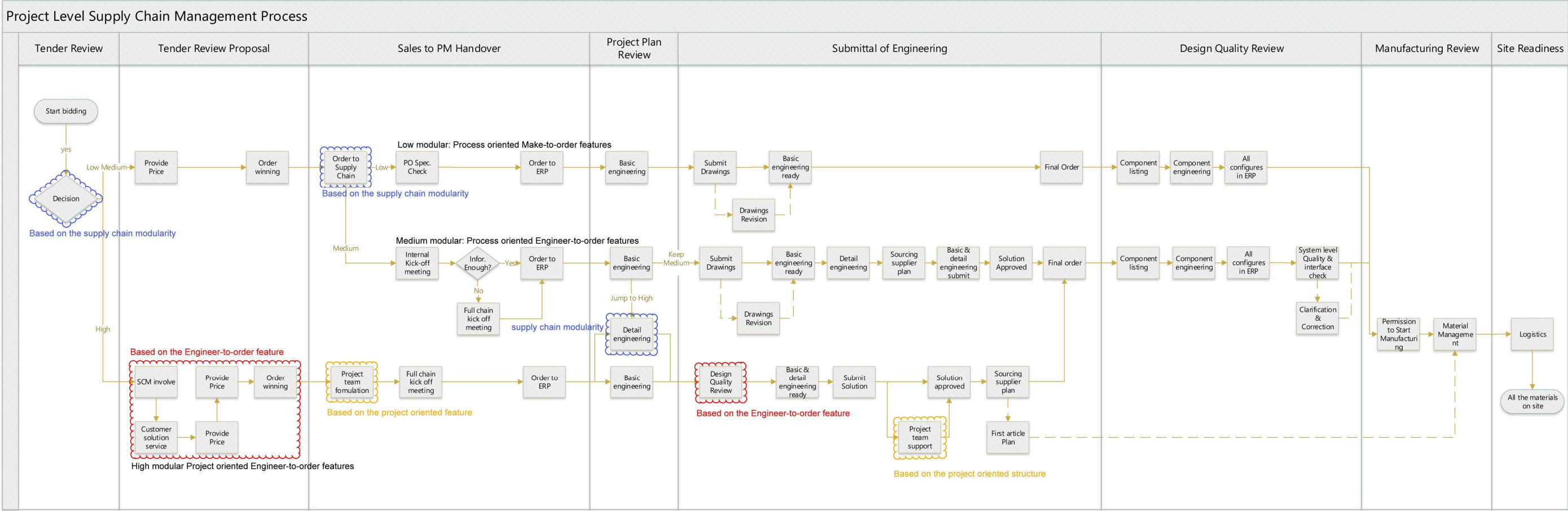


Figure 23. The final proposal for the harmonized SCM process.

As seen from the figure above, the harmonized SCM process is linked to the case company main project process which was introduced earlier in Section 3.

The different modules in the proposed SCM process are divided into eight different stages, based on the current company project logic. Moreover, the three modules are built based on three themes from the CF. First, the low module is MTO SC with process focus structure. Second, the medium module is ETO SC with process focus structure. Last, the high module is ETO SC with project focus structure.



## 7 Discussion and Conclusions

This section summarizes this study and discusses the actions for the next step from the researcher.

### 7.1 Summary

This thesis builds a harmonized SCM process based on the SC modularity for the case company. The objective of this thesis was to create a proposal of new SCM process for the two Finnish SC units of the case company. The new SCM process was needed by the case company because the current process is unit-based which generates the misunderstanding from the stakeholders. Additionally, the harmonized process is a common way for the case company in managing the project no matter who is managing it.

This study starts by mapping the current SCM process in two units, Unit A and B. It also identifies and analyses the major differences in these processes and also in their relevant documentation. This study divided the key differences between Unit A and B into three perspectives - *Organization structure*, *SCM process* and *SCM project resources*. These three perspectives were the deep reason which make the two SC units different. From the *organization structure perspective*, the difference is the customer solution/service department. From the *SCM process perspective*, the differences are (1) Unit A does a lot of check lists during the process when Unit B follows many process documents, (2) Unit A process is very strict and Unit B process is very flexible, and (3) Unit A does not have as much as enough collaboration as Unit B does. From the *SCM project resources* perspectives, Unit A is not project oriented and Unit B is.

The results of the current state analysis pointed to the themes for search in available knowledge for ideas and best practice how to approach harmonization in SCM units, from the perspective of SCM with project- or process- organization structure. Based on these ideas, the draft proposal was built after the project team discussion and one short interview with the program manager. In the final proposal, the SCM process map was simplified based on the management feedback. Finally, the new process was approved and linked to the company whole project process.

The study proposes a common SCM process by adopting a perspective to harmonization through the SC modularity. There are 9 modules in the draft proposal which in-

cludes the common modules and individual modules for different project complexity. There are also three levels of complexity modules proposed for the new SCM process. First, the low category is the MTO SCM with the process focus structure. Second, the medium category is the ETO SCM with the process focus structure. Last, the high category is the ETO SCM with the project focus structure. Moreover, the PCCPs are embedded in the process flowchart in different project phase which increase the dynamic and feasibility of the process.

The harmonized process provides a clarified picture for managing the projects by distinguishing them through complexity and customization level. Moreover, the case company could benefit from the common process because there is only one process needed to be developed, avoid extra development. Not only for the SC units, the FL employees could also benefit from the harmonized process, because there is only one way of working from the SC units, FL does not need to learn to work differently with different SC unit in managing the project.

## 7.2 Managerial Implications

This study was conducted to build a harmonized SCM process for the two case units. Before implementing this proposal into practice, there several considerations that need to be taken into account by the management.

First, it is necessary for the company to make a plan to implement and scale the process. Second, it is necessary to continue discussion on the research findings of this study including the differences and similarities. Since different SC units normally do not have any communication of what the others are doing, sharing experience definitely helps to improve the knowledge sharing which eventually results in better process and higher customer satisfaction.

In addition to producing an implementation plan and more knowledge sharing, the following table presents some other recommendations to implement the harmonized process in the case company.

*Table 15. Action plan for building the harmonized process.*

Step	What	Responsible
1.	Give the training to the project handler in both SC units	Program manager, process owner
2.	Pilot the process for all three complexity levels in projects	Directors of SC units
3.	Collect feedback systematically and discuss improvement recommendation for the process	Directors of SC units
4.	Improve and monitor the SCM process	Program manager, process owner
5.	Scale the process to the company level	Directors of SC units

As seen from the table above, the action plan for implementing the harmonized process is (1) training, (2) piloting on a small scale, (3) feedbacks and involvement, (4) improvement and monitoring, and (5) Scale the process. Once the harmonized process is taken into practice by the both units, a similar approach can be discussed for implementing to the SC units in other locations for the case company.

### 7.3 Evaluation of the Thesis

This study produces a real life outcome related to a case company project, conducted in a big-size global company. Based on the study, the new process will become part of the project main map for the company. This study has contributed to defining a suitable process for the SC unit when working with customized products in the construction business.

During the study process, the results of this study have become relevant not only for the ones who work in the SC units, but also for the FL employees. The modular based process gives the possibility for SC employees to work dynamically and become more agile. The FL employees could also learn about the SC process in order to work better with SC project handlers. This study can also be used as a training material for the case company since the author has specified the SCM process of two units mapped through the interviews, group discussions and internal documents reviews. As a training material, the study presents a concise picture of the units' processes that can be

used, for example, for training new employees. More importantly, the results can be used as a starting point for continuous improvement done in the case unit.

In addition, the study can be used for learning for a wide audience, from this study as a case example how to approach a challenge of harmonization in SCM units, which are involved in customized products or components. The idea proposed in this study is to approach harmonization by standardizing the two different types of SCM based on the identified modules into three levels of project complexity, and thus make the SC more dynamic to satisfy the customer needs.

#### 7.3.1 Outcome vs Objective

The objective of this study is to build a harmonized SCM process for the case company as discussed in Section 1.3. The CSA revealed the similarities and differences between the two units and set the main focus areas which gave the case company a comprehensive view of the SCM process. The final outcome of this study was a new, harmonized process for both SC units in managing projects. The process presented in this thesis is a modular-based SCM process, that provides the common process for two units in order to increase their agility. Thus, the objective and the final outcome seem to be matching.

#### 7.3.2 Reliability and Validity

The reliability and validity plan of this study was mentioned in Section 2. The validity of this study is proved through a series of steps taken in the thesis. The internal validity is achieved through three perspectives. First, the core team was established in order to make sure both SC units project handlers were involved in the process building. Secondly, there were four group discussion held with the project team. Moreover, an extensive series of semi-structured interviews were done with the project handlers from both SC units. Finally, the internal documents were reviewed by the researcher and the project team. The external validity was achieved through the variety of literature review from different resources and fields.

The reliability is ensured from three perspectives in this study. First, over sixty documents from Unit A and B were reviewed and studied in order to ensure the compre-

hensive view of the current SCM process. Secondly, the program manager leads this project and sets up a core team for the development of the study topic. The group discussion involves four experts from both SC units which ensure the comprehensive view for both units. For Data 1, the core team was settled up to define the scope of the harmonized process and provides the very experienced view of current process. For Data 2, the core team members give the opinion and co-created the module based SCM process. For Data 3, the program manager approves the harmonized process and asks to link the SCM process to the company main project structure. In addition, the company internal documents are reviewed and studied in order to get rid of the unnecessary documents and highlight the important ones during the group discussion. Thus, the reliability was ensured by conducting: (1) interviews from different perspectives, (3) data collection in 3 rounds, and (3) combining the identified relevant theory with the company-relevant results from CSA.

#### 7.4 Closing Words

Finally, although the study aimed to address as thoroughly as possible the identified challenged in harmonizing SC units, there are some limitations in this paper. First of all, the study focuses on the supply chain in the construction business which has customized products and mature, well developed processes. Secondly, the literature reviews in this study is mostly focused on the European way of managing SCM, yet a vast amount of literature is now also available, from example, in Chinese and other SCMs. Thirdly, the paper would be better supported if the financial report could be included.

All these challenges are waiting for the next researcher to handle, which the author of this study warmly greets and looks forward with high interest to continuation.

## References

- Aloini, D., Dulmin, R., Mininno, V. and Ponticelli, S. (2015), "Key antecedents and practices for Supply Chain Management adoption in project contexts", *International Journal of Project Management* 33 (2015) 1301 – 1316.
- Artto, K., Kujala, J., Dietrich, and Martinsuo, M. (2007), "What is project strategy", *International Journal of Project Management* 26 (2008) pp. 4–12.
- Anders Haug Klaes Ladeby Kasper Edwards, (2009), "From engineer-to-order to mass customization", *Management Research News*, Vol. 32 Iss 7 pp. 633 – 644.
- Baldwin, C. Y., and Clark, K. B. (1997), "Managing in an age of modularity", *Harvard Business Review*, September - October 1997, pp. 84-93
- Bask, A., Lipponen, M., Rajahonka, M. and Tinnilä, M. (2011), "Framework for modularity and customization: service perspective", *Journal of Business & Industrial Marketing*, Vol. 26 Iss 5 pp. 306 – 319.
- Brewer, P.C. and Speh, T.W. (2000). Using the Balanced Scorecard to Measure Supply Chain Performance. *Journal of Business Logistics*. Vol. 21 (1), 75-93.
- Briscoe, G. and Dainty, A. (2005), "Construction supply chain integration: an elusive goal?", *Supply Chain Management: An International Journal* 10/4 (2005) pp. 319-326
- Camero, N. S. and Braiden, P. M. (2002), "Using business process re-engineering for the development of production efficiency in companies making engineered to order products", *Int. J. Production Economics* 89 (2004) 241-273.
- Childerhouse, P., Lewis, J., Naim, M. and Towill, D. R. (2003), "Re-engineering a construction supply chain: a material flow control approach", *Supply Chain Management: An International Journal* Volume 8 No. 4. 2003. PP. 395-406.
- Christopher, M, (2000), "The Agile Supply Chain-Competing in Volatile Markets", *Industrial Marketing Management* 29, 37–44 (2000).

- Christopher, M and Towill, D. R. (2000), "Supply chain migration from lean and functional to agile and customised", *Supply Chain Management: An International Journal*, Vol. 5 Iss 4 pp. 206 – 213.
- Cooper, M. C., Lambert, D. M. and Pagh, J.D., (1997),"Supply Chain Management: More Than a New Name for Logistics ", *The International Journal of Logistics Management*, Vol. 8 Iss 1 pp. 1-14.
- Eisenhardt, K. M. (1989). "Building Theories from Case Study Research". *Academy of Management Review*, 1989, Vol. 14, No. 4, 532-550.
- Eisenhardt, M. E. and Graebner, E. M. (2007): *Theory Building from Cases: Opportunities and Challenges*. Vol. 50, NO. 1, 25-32.
- Fisher, M. L. (1997), "What is the right Supply Chain for Your Product". *Harvard Business Review*, March-April, 1997. pp.105-116
- Gosling, J. and Naim, M.M (2009), "Engineer-to-order supply chain management: A literature review and research agenda", *The Journal of Production Economics* 122 (2009) 741-754.
- Gillham, B. (2010). "Continuum Research Methods : Case Study Research Methods (1)". London, GB: Continuum, 2010. ProQuest ebrary. Web. 25 April 2016.
- Hagel, J., Heygate, R., Laird, R. and Prang, G. (1993), "The power of process redesign", *The McKinsey Quarterly* 1993, No.1.
- Handfield, R. B. (1994), "Effects of Concurrent Engineering on Make-to-Order Products, *IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT*, VOL. 41, NO. 4, NOVEMBER 1994.
- Hammer, M. and Stanton, S., (1999), "How Process Enterprises Really Work", *Harvard Business Review*, November-December 1999.

- Hyväri, I. (2005), "Project management effectiveness in project-oriented business organizations", *International Journal of Project Management* 24 (2006) 216–225.
- Jahnukainen, J. and Lahti, M. (1999), "Efficient purchasing in make-to-order supply chains", *Int. J. Production Economics* 59 (1999) 103-111
- Jha, N.K. (2008). "Research Methodology", 1st edition. Abhishek Publications, India. 9789350436332
- Karim, M.A., Samaranayake, P., Smith, A.J.R. and Halgamuge, S.K. (2008), "An on-time delivery improvement model for manufacturing organisations". *International Journal of Production Research*, Vol. 48, No. 8, 15 April 2010, 2373–2394
- Kujala, K., Ahola, T. and Huikuri, S. (2012), "Use of services to support the business of a project-based firm", *International Journal of Project Management* 31 (2013) 177–189.
- Majchrzak, A. and Wang, Q. (1996), "Breaking the Functional Mind-Set in Process Organizations", *Harvard Business Review*, September-October 1996.
- Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. and Zacharia.(2001), "Defining Supply Chain Management", *The Journal of Business Logistics*, Vol.22, No.2, 2001.
- Michalik, B., Keutel, M., Müller, S. and Basten, D. (2003), "Reducing Requirements Heterogeneity in Enterprise System Projects – A Case Study of Harmonizing and Optimizing Business Processes". 46<sup>th</sup> Hawaii International Conference on System Sciences, pp. 4084-4093.
- Norta, A and Eshuis, R, (2009), "Specification and verification of harmonized business-process collaborations", Springer Science + Business Media, LLC 2009.
- Ostroff, F. and Smith., D., (1992), "The horizontal organization", *The McKinsey Quarterly* 1992, No.1.



- Pandit, A. and Zhu, Y. (2007), "An ontology-based approach to support decision-making for the design of ETO products", *Automation in Construction* 16 (2007), pp. 759–770
- Pekkarinen, S. and Ulkuniemi, P. (2008), "Modularity in developing business services by platform approach", *The International Journal of Logistics Management* Vol. 19 No. 1, 2008 pp. 84-103
- Peter E.D. LoveZahir IraniDavid J. Edwards, (2004),"A seamless supply chain management model for construction", *Supply Chain Management: An International Journal*, Vol. 9 Iss 1 pp. 43 – 56
- Quinton, S. and Smallbone, T. (2006). *Postgraduate Research in Business: A Critical Guide*. Sage Publications.
- Segerstedt, A. and Olofsson, T. (2010). "Supply chains in the construction industry", *Supply Chain Management: An International Journal*, Vol. 15 Iss 5 pp. 347 – 353.
- Stevenson, M., Hendry, L.C. and Kingsman, B.G. (2004), "A review of production planning and control: the applicability of key concepts to the make-to-order industry", *International Journal of Production Research*, Vol, 43. No. 5. 1 March 2005. 869-898
- Sunil, C. and Meindl, P. *Supply Chain Management-strategy, Planning, and Operation*. Sixth edition.
- Yin, R. K (2009) *Case Study Research: Design and Methods*. 4<sup>th</sup> ed. SAGE Publications, Inc.
- Vanhaverbeke, W. and Torremans, H., (1999), *Organizational Structure in Process-based Organizations. Knowledge and Process Management*. Volume 6. No.1, pp 41-52 (1999).

Voordijk, H., Meijboom, B. and De Haan, J. (2006), "Modularity in supply chains: a multiple case study in the construction industry", *International Journal of Operations & Production Management*, Vol. 26 Iss 6 pp. 600-618.

Vrijhoef, R. and Koskela, L (2000), "The four roles of supply chain management in construction", *European Journal of Purchasing & Supply Management* 6 (2000) 169-178.

## **Appendix 1.**

**REMOVED**

## **Appendix 2.**

**REMOVED**

### **Appendix 3.**

**REMOVED**

## **Appendix 4.**

**REMOVED**

## **Appendix 5.**

**REMOVED**